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Desulphurisation with Caustic Soda

The addition of alkalis to foundry iron and to other grades of pig-iron has become rather a common practice during the past few years, and more recently interest in the use of alkali desulphurising agents has been stimulated by the Brassert method developed at Corby for desulphurising iron outside the blast furnace and thereby producing basic iron low in both silicon and sulphur. While blast-furnace operators are interested in economies of operation, which appear possible through the control of sulphur outside the blast furnace, foundrymen are primarily interested in obtaining metal of lower sulphur content, and any new investigation with this object in view must be of interest to them. Particular interest therefore attaches to the results of certain researches carried out recently in the United States dealing with effect of treating cast iron with caustic soda.

In the experiments under consideration fused caustic soda was added in successive small quantities below the metal surface by means of a steel cup, resulting in a vigorous reaction which assured a thorough distribution of the alkali and a rapid elimination of sulphur. The results obtained by this new method of treating cast iron, when considered in respect of the elimination of sulphur, in the changes produced in the chemical and oxide analysis, and in their effect on the transverse strength and the microstructure, lead to some interesting conclusions.

The decrease of sulphur is the most marked change in the analysis of the iron, and the efficacy of the caustic varies with the concentration of sulphur, decreasing with lower sulphur concentrations, a result which is of importance to producers of pig-iron who hope to reduce the sulphur in iron below 0.030 per cent. for use in the basic open-hearth furnace. So far as foundry iron is concerned, the transverse strength is increased by the addition of caustic soda, and this increase indicates some change in the physical nature of the iron. Microexamination indicates that, although the graphite flakes show a tendency to be finer and less bulky after treatment, increase in transverse strength cannot be entirely attributed to this cause, but depends more on the removal of sulphur. Although no direct evidence is produced to support such a conclusion, it is considered that the removal of sulphur with a corresponding increase in the ratio of manganese to sulphur diminishes any adverse influence the sulphide network might have on the transverse strength.

As regards the efficiency of alkalis in removing sulphur, it is demonstrated that additions of caustic soda below the surface of the metal show a somewhat greater efficiency than additions of soda ash to the surface of the metal. The development, therefore, of a practical method for the introduction of alkali below the surface of the metal allows of the complete treatment of the metal in one ladle, simplifies the layout, increases the efficiency, and thereby reduces the overall cost, which is of importance in view of the fact that the initial cost is increased slightly by the use of caustic soda.

Labour Control

There are within the foundry industry a number of high-grade executives who are never quite successful because of their apparent inability to control labour. This quality of leadership is inherent, and we doubt very much if it can be taught, for the simple reason that the qualities exhibited by labour are so diverse as to defy standardisation and analysis. There is one saving grace, however, and that is the executive now being considered usually is well aware of his weakness and, that being so, is open to receive advice. Thus, if the weakness is known, it is obviously desirable to minimise as far as possible the scope of control by delegating the maximum to either a foreman or charge hands. One of the most successful foundry managers in the country, whenever he notices any slackness or irregularity, invariably limits his remarks to the delinquent to "Don't let your foreman see you doing that." If the perplexed executive can solve his problem by delegation of such a duty, he must insist that no person higher in authority than himself usurps the duties he has delegated, otherwise there is more than a chance that he will be looking for a new post. In dealing with labour, it is the unexpected reaction to some question or happening which commands respect. For instance, an attempt to expose the ignorance of an executive on some phase of operation can usually be countered by "What would you do if I were away from the works?" The difficulty is that the executive, deficient in the quality of labour control, usually provides himself with a lieutenant equally weak in this respect, because he recognises that such qualities are so readily appreciated by the directorate that such an appointment would endanger his position. The qualities of labour vary so much in the different districts that in some places, fortunately, this inherent weakness does not react too badly.

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Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Pig-Iron Supplies

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I notice a letter under the above heading in your correspondence columns of January 5. Certain statements are made which seem to us misleading. The suggestion is put forward that "it is high time that pig-iron production was modernised, at least to the extent of supplying it machine-cast." This view is surprising, since machine-cast foundry pig-iron can now be obtained in a number of varying qualities, from low- to medium-phosphorus irons, and even to the higher-phosphorus irons.

Our own experience in the supply of the latter confirms beyond doubt that there is still considerable prejudice against any alteration in the physical appearance of pig-iron, and it should be remembered that there are approximately 3,000 foundries in this country—the vast majority of which are still operating what are generally described as "rule-of-thumb" methods; it is even argued in some quarters that chemical analysis is not all that matters, and that fracture has a distinct bearing on the ultimate casting.

There are considerable advantages to be derived from the use of machine-cast iron, which are appreciated by a number of the larger consumers, but there are prejudices from the vast majority of founders which are only slowly being overcome.

The question of analysis is also raised by your correspondent, but for some time the leading manufacturers have been willing to guarantee their supplies to narrow limits—even less than the tolerances which were recently put forward by the British Cast Iron Research Association, but this consistency of supply to a specific analysis can only be obtained by close metallurgical control on the part of the supplier.

My company furthermore have, in recent years, spent considerable sums of money in providing the trade with a free advisory service on metallurgical matters, and in fact on any problems connected with the foundry, which service has been welcomed and appreciated by a vast number of pig-iron users.

Yours, etc.,
E. J. Fox
(Managing Director, the Stanton Ironworks Co., Ltd.).

Near Nottingham.
January 16, 1939.

Publication Received

The Meehanite Monthly Review. Published for private circulation by the International Meehanite Metal Company, Limited, 66, Victoria Street, London, S.W.1.

It can be presumed that the average foundryman regards the activities of the Meehanite staff as devoted to the application of the latest inoculation theories to the production of sound castings, yet included in the first issue of this magazine there are several notes which any moulder would appreciate. A very neat method of dealing with an elongated casting for which no special box parts were available is described and illustrated. There are some really practical notes on cupola operation, whilst a method of mounting patterns on plywood of a very special type is again most useful to the practical man. The objects of the Bulletin are to afford a means of co-operation between the various licensees of the process for such matters as publicity, advertising, improved foundry technique, and ameliorated technical control, and to judge by the issues which have been made available to us, these objects have been splendidly attained.

Wages in the Light-Castings Trade

A settlement has not yet been achieved at Falkirk where the workers engaged in the manufacture of rainwater goods have been asked by their employers to accept a 7½ per cent. "cut" in wages.

The men held a ballot last week, and the result, which was intimated on Monday, showed that, by a small majority, they had voted against the acceptance of the reduction. Their attitude is contrary to the opinion of their trade union executive, who have recommended the workers to acquiesce with the employers' proposal.

When interviewed on the situation, Ex-Provost A. G. Logan, who is national organiser for the Ironfounding Workers' Association, said: "The majority is too small to justify a stoppage of work. A majority of two-thirds is required before strike action can be taken, but I am very hopeful that this will be obviated. At present, I am trying to arrange another meeting with the employers to discuss further ways of reaching an amicable settlement."

Interviewed the same day, Mr. George Scotland, managing director of Falkirk Iron Company and President of the National Light-Castings Ironfounders' Federation, acknowledged receipt of the workers' decision. He agreed that another meeting between the executives of both parties was required, and said he would try to arrange the meeting towards the end of the present week.

Foundry Exports to British East Africa

According to MR. A. E. POLLARD, H.M. Trade Commissioner for East Africa, in his Report on Economic and Commercial Conditions in East Africa (published by H.M. Stationery Office, price 1s. 6d. net), the increased buying capacity of the native led to an increase in the imports of Japanese enamelled hardware in 1937. In 1936, the value was £27,572, but the next year saw it rise to £49,492. German imports decreased somewhat, but the British rose from £4,691 to £6,531. It is needless to say that neither quality nor price makes the Japanese and British products comparable.

Cast-iron pipes showed an increased consumption, the market being shared between the United Kingdom and Germany, the figures for 1937 (1936 in brackets) being respectively 4,512 tons (3,361) and 611 tons (318).

Cast-iron sanitary ware from the U.K. showed little change at about 235 tons during the two years. At the moment the bazaars are rather over-stocked with goods, but as the market is fairly sensitive, conditions may rapidly change, and exporters should be on the alert.

(Continued from next column.)

beautifully produced map of Great Britain, showing just where they produce "summat good t' eat." It is a sort of "carte gastronomique d'Angleterre." And although any gastronomic map of this island looks bare against that of France, yet there are good things made and of their kind are perfection. A charming personal touch is added at the side of the map, the one "Marksman" has seen in the Editor's room reading: "As every county is known for its produce, so are V.C.F. and his journals known for their industrial and technical news." And, by the way, what are the wild waves saying? Not to mention the little message on the boats!

"MARKSMAN."

Random Shots

The early minutes of the Manchester Association of Engineers, extracts from which have just been compiled in book form by the Vice-President, Mr. A. C. Dean, make fascinating reading. Like most technical societies, it had an infancy full of teething troubles, the greatest of which in this case was the finding of suitable accommodation. Then followed a period of financial trouble and a display of disheartening apathy on the part of the members. The whole of the early history, indeed, seems to have been a vain search for the right "pub" in which to hold meetings, for the members "enjoyed their pipe and glass during the reading of papers." The present-day fashion favours going on the binge after the meeting, and occasionally before, which procedure usually has disastrous effect on the attendance at the meeting itself. At first a contribution of sixpence was made towards refreshment, but discussion is thirsty work and it was later deemed advisable for members to pay for what they drank as they ordered it. A very wise decision!

* * *

The reported speeches after the annual dinners contain some amusing reflections and comments. Sir William Fairbairn at one dinner recalled that when he first came to Manchester in 1813 there was hardly a lathe in the town. At another, Mr. Bailey expressed the thought that "engineers might have opened their mouths a little sooner on this subject, and so put a stop to gas panics, for he considered Mr. Edison's invention was about the clumsiest method of getting a light and that Mr. Edison ought to be ashamed of himself for kicking up such a fuss about nothing." At yet another, Mr. Belhouse deplored the fact that "within the next two or three years the Botanical Gardens at Old Trafford would be so much injured by smoke, in consequence of the railways in that vicinity, that they would be worth nothing as a pleasure resort." The telephone, on the other hand, was pronounced to be an invention that would prove ere long to be a wonderful thing.

* * *

Amongst the discussion on Papers is one on foundry cranes. The leisurely conditions of the period (1882) are emphasised by Mr. Macleod, who considered that "the expenses attending the travelling crane are enormous, the going up and down all day long takes up a vast amount of time and makes them a great bore, in fact a nuisance."

* * *

Finally a piece of advice given by a later chairman to would-be inventors would serve equally well to-day. He always asked them: "Have you made yourself familiar with the failures and work of other men in the direction in which you are now working?" "Do you know the work of the best men, and do you think you are better than the best?" "Have you read all the published literature on the subject?"

* * *

Orders for foundries are not always prosaic, and a request recently received by a London firm comes as a refreshing change from manhole covers and firebars. It is a request from an overseas friend who requires for his garden "four cast-iron Grecian statues, life size, two men and two women; the statues to be erected on stones provided at site." This is serious, and any interested foundry may quote.

* * *

The palm surely must be handed to Mr. J. H. Gray for this year's most original idea in seasonal greetings. It takes the form of a

(Continued in previous column.)

Steel Castings for Motor Vehicles*

By R. H. CARROL

In presenting a Paper on the contributions of the Ford Motor Company to the development of motor steel castings, it is felt to be unnecessary to describe in detail the materials and methods used on parts which have been in production for some time. Many of these major developments, such as the casting of valves, crankshafts, pistons, and the like have been fully described previously. Instead these early parts will be only mentioned, giving the date of first large-scale production and an estimate of the number and weight so far produced. Reference will be made later to some of the work now in progress, although changes and improvements come so rapidly that some of this may soon seem like ancient history; finally, it is proposed to discuss briefly what these developments may mean to the industries concerned.

At present there are not less than 149 lbs. of finished cast steel parts entering into each Ford car. The phrase "not less" is used because this is being exceeded in cases of experimental production on some parts. The normal parts are as follow:—

Valves.—Started in 1931, over 56½ million have been produced, weighing finished more than 5,225 tons.

Crankshafts.—Started in 1933, over 4½ million have been produced, weighing finished more than 137,000 tons.

Valve Seats.—Started in 1934, more than 34 million have been produced, weighing more than 695 tons.

Wheel Hubs.—Started in 1935, over 8¼ million have been produced, weighing more than 67,850 tons.

Pistons.—Started in 1935, more than 16 million have been produced, weighing more than 5,000 tons.

While this Paper deals with the use of cast steel parts, it might be well to illustrate here two notable exceptions where alloy iron parts have replaced steel forgings. These are the push rod and camshaft. These two parts have been selected because of their unusual composition and treatment, because they have replaced steel parts and because they have so improved quality and decreased cost.

The V-8 push rod was started in 1933, and over 60 million have been produced, weighing more than 3,500 tons. The camshaft was started in 1935, and over 3 million have been produced, weighing more than 12,000 tons. Their manufacture has been described on several occasions in the technical Press.

As an introduction to the work now in progress, the analyses of the materials available and their physical properties are worth examination. For convenience in specifying, the list of cast steels has been divided into seven classes, and in addition there are special analyses for the valve and valve seat inserts. These specifications are shown in Table I, which chart includes class number, representative parts, analyses and some typical heat-treatments.

There has been considerable discussion as to the correct appellation for some of these materials, particularly in the higher carbon ranges like that used for crankshafts. Amongst the bibliography there is an interesting article by Mr. H. W. Russell, of the Battelle Memorial Institute, on "Resistance to Damage by Overstress of Precipitation-Hardened Copper-Steel and Copper-Malleable."† The publishers were kind enough to include with this article some comments by the present author giving his reasons for classifying this material as steel, rather than under the term "pearlitic malleable" used by Mr. Russell. Because it is felt that this is important the comments are repeated below:—

(1) Referring to the iron-carbon diagram, this material is within the range previously defined as steel.

(2) The modulus of elasticity of this material is within the usual steel range, being from twenty-eight to thirty million, and not within that of grey iron or that of malleable iron.

(3) Referring to the publication of a discussion at a meeting of the American Foundrymen's Association on Pearlitic Malleable Irons presented January 27, 1936, at Cleveland, reference is made to high-carbon cast steel as differentiated from pearlitic malleable because such steels as cast are solid, homogeneous single-phased alloys. It is thought that this crankshaft material meets with these definitions of the A.F.A. for high carbon cast steel.

(4) The Ford Motor Company has a so-called "quick malleable" often given a heat-treatment, leaving it purposely partially pearlitic, referred to in U.S. Patent No. 1,871,545 (McCarroll and Vennerholm).

(5) This crankshaft material does not meet the definition given by Bornstein and Bolton in the A.S.M. Handbook for any type of cast iron.

In addition to these technical reasons, there are, it is thought, some very practical reasons. Among the general public, non-technical executives, and others who are not familiar with the progress in cast metals in the last few years, cast iron means a weak brittle material. Many of these people think of cast iron and, in some cases, all cast materials, as stove-plate iron which, when they drop it on the floor, will break into many pieces. It is a personal opinion that the foundry industry and others equally well versed should help in this matter of definition as a means of education regarding the difference in physical properties, and the suitability of some of these newer materials for parts which could not previously be cast satisfactorily. The term "satisfactorily" really is far too weak here. While numerous manufacturing advantages resulting from a change to steel castings are cited below, it is as well to emphasise that the cast steel parts have almost always given better results in actual service than the forged part it replaced, and always at least as good. Another requirement is that the cast part must never weigh more. In almost all cases the weight has been less.

TABLE I.—*Chemical Analyses of Steels Used.*

Type.	Parts.	C.	Si.	Mn.	S.	P.	Cr.	Cu.	Heat-treatment and hardness.
1	Clutch pedals; steering-wheel hubs	0.15–0.35	0.6–0.8	0.40–0.60	0.08 max.	0.08 max.	—	1.5–2.0	Normalise to B.H. 163–207.
2	Lorry ring gears and parts to be carburised	0.28–0.35	0.40 max.	0.30–0.45	0.05 max.	0.05 max.	0.90–1.20	0.50–1.50	Normalise. Carburise and direct quench, or reheat and oil-quench and temper to Rockwell "C" 58 to 62.
3	Centrifugal castings; trans. countershafts and diff. ring gears	0.35–0.40	0.40 max.	0.65–0.80	0.05 max.	0.05 max.	0.90–1.10	0.50–1.50	Normalise to B.H. 170–196. Harden gears as per part prints.
4	Rear axle shaft housing flange; lorry universal joint housing; connecting rods	0.35–0.45	0.40 max.	0.70–0.90	0.08 max.	0.10 max.	—	0.50–1.50	Normalise to B.H. 163–207. Universal joint housing to remain as normalised. Connecting rods oil-quenched and tempered to B.H. 255–286.
7	Lorry rear-axle housing tube	1.35–1.55	0.90–1.10	0.40–0.60	0.08 max.	0.10 max.	0.08 max.	—	Normalise to B.H. 170–228.
8	Crankshaft bearing sleeves and parts to be hardened	1.35–1.60	0.85–1.10	0.70–0.90	0.08 max.	0.10 max.	0.40–0.50	1.50–2.0	890 deg. C. at heat 20 mins. Air-cool to max. of 648 deg. C. Reheat to 760 deg. C. Hold for 1 hr. Furnace-cool to 537 deg. C. Brinell 255–321. Parts to be hardened may be oil-quenched and tempered to Rockwell "C" 52–60.
9	Piston	1.40–1.60	0.90–1.10	0.80–1.0	0.08 max.	0.10 max.	0.08–0.15	1.0–1.5	900 deg. C. at heat 20 mins. Air-cool to a max of 648 deg. C. Reheat to 760 deg. C. Hold for 1 hr. Furnace-cool to 537 deg. C. in 1 hr. B.H. 190–228.
—	Valve insert ..	1.20–1.40	0.30–0.60	0.30–0.50	W 14.0–17.0	—	2.5–3.5	1.5–2.0	787 deg. C. at heat 30 mins. Cool in 3 hrs. to 537 deg. C. Rockwell "C" 38–46.
—	Valves	0.95–1.20	2.0–3.5	0.20–0.30	Ni 14.0–15.0	—	15.0–16.0	—	Rough-grind. Re-strike. Anneal at 845 deg. for 30 mins. Cool slowly, Rockwell "C" 22.

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* Paper read before a Sectional Meeting of the American Foundrymen's Association at Ann Arbor.

† "Metals and Alloys," December, 1936.

In Table II only the simple physical properties of some of the cast materials such as shown in Table I will be considered. An attempt has been made to select average results and compare them with ordinary malleable, Ford's so-called quick malleable and rolled steel. Later, consideration of fatigue tests, notch effect or the effect of grain flow as a result of forming will be undertaken.

Work in Progress

Parts which are on small-scale production will be considered under two divisions: (1) those which are being sand-cast in stationary moulds, and (2) those which are being centrifugally cast in permanent moulds. Illustrating some of these newer sand-cast parts, attention is drawn to Fig. 1. At the top of this photograph will be seen a casting for a lorry rear-axle housing. Two of these are used in each lorry, being riveted to each side of the centre malleable bell housing castings to make the complete axle housing assembly. Immediately beneath this casting is shown the previous tubular section, swedged down on the end and the two forgings which were welded on, in the positions shown, to make an assembly. In this case there is one casting taking the place of three separate components. Attention is drawn to the comparative wall thickness of different sections of these parts as made by the two different methods. Being able to vary the wall thickness as desired and put the metal just where necessary is a great advantage in favour of castings. This casting is made from copper-silicon No. 7, and annealed and air-cooled to a Brinell hardness of 170-228.

The casting shown at the lower left of Fig. 1 is that of a rear axle end and spring perch for a passenger car. Beside it are shown the two forgings which were formerly welded together, at the place shown, to make an assembly. Here, one casting replaces two forgings. The castings for this part are made from copper-silicon No. 4 (Tables I and II), and are heat-treated to a Brinell hardness of 163-207. Two castings are used per car, and they are butt-welded to the outer ends of the rear axle housing tube.

The third part shown at the lower right of Fig. 1 is the lorry drive shaft universal end. Here, one casting replaces only one forging, but there is a considerable weight advantage in that the rough casting weighs only 8½ lbs., while the rough forging weighs 10 lbs. 6 ozs. The weight of the finished machined part is 6 lbs. 1 oz. One of these parts is used in each truck and is butt-welded to the front end of the drive shaft tube. The material specified is copper-silicon No. 4. The castings are normalised before machining in the same manner as the forging.

The reason that malleable castings cannot be used for these parts, even if the sections were made large enough to have sufficient strength, is, of course, because of the welding of these parts into the assembly.

There are many other parts under this classification which are being cast experimentally, either by the Ford concern or its suppliers, but it is not thought worth while to bring them into this discussion.

FIG. 1.—NEW SAND-CAST MOTOR-VEHICLE PARTS.

FIG. 2.—STEEL MOULD AND CORES FOR CENTRIFUGAL CASTING OF THE GEARS SHOWN ON RIGHT.

TABLE II.—*Comparative Physical Properties of Test-Bars.*

Type.	E.L. Tons per sq. in.	M.S. Tons per sq. in.	Elongation in 2 in.	Brinell hardness.
1	23.6	31.7	18.5	163
2	25.2	34.8	16.5	170
3	27.7	38.4	16.0	184
4	29.0	40.5	15.2	187
4, hardened	48.3	57.4	10.0	277
7	37.5	47.0	9.0	207
8	42.4	53.7	6.5	255
9	37.9	46.7	7.5	229
Regular malleable ..	17.0	23.2	15.7	119
Ford malleable ..	19.2	27.0	14.0	140
0.3 per cent. carbon forged steel	26.8	37.9	27.0	165
0.4 per cent. carbon forged steel	35.7	49.1	20.0	225

Centrifugal Casting of Steel Parts

Foundrymen are all familiar with the centrifugal casting of iron pipe and the work done in centrifugally casting iron against steel backing plates. Even the centrifugal casting of steel is not new, railway truck wheels have for many years been manufactured by this method, and much work has been done on the centrifugal casting of steel ingots and billets. It is thought, however, that the centrifugal casting of relatively small parts, such as will be described, is new. Three of the main advantages of this method of manufacture are:—(1) Better structure; (2) extremely high yield of castings when compared to shop scrap, and (3) the ability to use a less fluid metal, which means lower pouring temperatures and less damage to the mould, and also the possibility of more easily casting lower carbon steel.

The centrifugal casting machine consists essentially of a turntable 22 ft. in dia., on which there are 18 stations for rotating heads. There are as yet (at the time of writing this Paper) only six heads or pouring stations installed.

FIG. 3.—CENTRIFUGALLY-CAST STEEL GEARS.

The turntable makes one revolution every four minutes. Each head is driven by an individual motor rotating at 400 r.p.m. It is estimated that this machine, when completed, should produce more than 8,000 gears, such as the transmission cluster gear, 16 hrs. The pouring temperature is about 1,590 deg. C.

(*Continued on page* 90.)

Manufacture of Chilled and Grain Rolls

At a meeting of the Staffordshire Iron and Steel Institute, held on January 5, MR. W. H. LEWIS delivered his presidential address on "Progress in Chilled- and Grain-Roll Manufacture," in the course of which he reviewed the early phases of the industry and the very trying working conditions in which production was carried on. In spite of these circumstances, Staffordshire had succeeded in consistently producing rolls of very high quality.

Coming down to modern times, the speaker said that the most conspicuous change in roll plants to-day, compared with 30 or 40 years ago, was in the buildings and lay-out of plant. It was doubtful if there was any roll foundry still operating in the same buildings as were in use at the commencement of this century.

Advent of the Metallurgist

The important change in roll-foundry practice was the advent of the metallurgist, with technical training and with the knowledge which the sciences and practical research had provided for application to the craft. This did not mean, however, that science had replaced craft in industry. In the author's judgment, the function of science was to replace ignorance and guesswork by more precise knowledge. Roll-making was not, and never would be, a science, and the metallurgist who produced rolls was still a craftsman with a tremendous advantage in training and knowledge over his predecessor. The works' laboratory had become a necessary instrument in the control of routine operations as well as a department of research for the improvement of works' practice and the quality of the product.

Cold-blast iron was still the basis material, having inherent in itself the combination of strength, toughness, hardness and chill necessary to produce chilled rolls. Many investigations had shown that mixtures of different irons, although they might have the same final analysis, could in similar castings made under identical external conditions, have very dissimilar structures and mechanical properties, and research had discovered scientific explanations for some of those anomalies. Among those not yet fully explained, however, was the difficulty of reproducing in other irons all the characteristics of cold-blast pig-iron which contributed to the making of a good chilled roll. Even cold-blast irons giving the same fracture and chill on test could vary widely in analysis, and a freak analysis could seriously affect the relation between chill on the test-bar and chill on the roll. Selection by analysis had done much to reduce this disturbing factor. Secondly, it was only by analytical control of mixtures that the elements could be balanced to give the wide range of roll qualities now called for. Further, the proper effect of the alloys used for special purposes could only be obtained by an equally careful control of the alloys themselves and of the elements normally found in the basis mixture.

The Air Furnace

The air furnace was still the most common and most suitable melting unit. In general there had always been two types of furnace construction, the reverberatory with camel back roof or a flat roof. The former was the original Staffordshire furnace, and was still popular. It had been replaced in some cases, especially with pulverised-coal firing, by the flat-roofed furnace. Many furnaces were still hand-fired, but a better understanding of the principles of furnace design, maintenance and control had made these furnaces much more reliable than they used to be. The air furnace was, thermally, a most inefficient machine. The only excuse for its survival was its ability to melt large lumps and to produce a high-quality iron, free from direct contamination by the fuel, and retaining the properties of the charge.

The general melting practice elsewhere was to charge the cold furnace and then commence firing. In Staffordshire the furnace was heated up first and charged when hot, firing being then resumed. Melting from a cold-charged furnace was much more economical, and often showed a saving of 50 per cent. in fuel consumption, but in this district it was believed that the advantages in control and in quality of melt obtained by using a new sand bottom for each charge and by the quicker melting time outweighed economy in fuel.

Service Conditions

It was no exaggeration to say that cast-iron rolls were subjected to heavier service conditions than any other type of iron casting. At work, they suffered sometimes intermittently, sometimes continuously, and often simultaneously all the known forms of mechanical stresses—compression, tension, transverse and torsion. They had to withstand high temperature and wide variations of temperature over short- and long-time cycles. Their desirable properties could be classified under two heads: (1) The body of the roll must have strength to resist breakage, either by direct load or by stresses due to heat. It should be as free as possible from inherent casting stresses. (2) The surface must be highly resistant to abrasive wear, and to deformation under heavy pressure. In hot rolling it must withstand local temperature variations which cause cracking or crazing. For cold rolling of flat products, the demand for a high finish called for a very hard chill surface, which would take a fine polish and would not mark or spall. These were the properties of surface necessary to obtain good tonnage output and to maintain the form and finish on the rolled material.

Strength to resist breakage, hardness to resist wear and a structure which would resist heat did not seem to be a natural combination in one material, and they could only be obtained at joint maximum by compromise. Rolls had the saving grace of large compact mass, which promoted a strong tough structure in the body, while permitting a controlled hardening of the surface. It was fair to say that without the many modern improvements introduced during post-war years the increasing use of the latest types of high-duty rolls would not be possible. Increase of roll sizes, modern types of bearing, improved driving units and auxiliaries, increased power, better control of temperature of the stock and proper cooling of rolls had all contributed to better working conditions. Mill plant, however, was an expensive capital item and during periods of good trade and development it was sometimes necessary to attempt heavier work and faster production than was originally intended. Under such circumstances, roll strength became the important factor, and often prevented the use of the type of roll with the most suitable surface properties.

Sizes and Uses of Various Rolls

Grain rolls ranged from 8 in. to 36 in. of mill centres and from a few hundredweights to 20 tons in weight. Chilled rolls ran from 6 in. to 44 in. in dia., and from 7 in. to 14 ft. length of barrel and from one hundredweight to 40 tons in weight.

The ordinary grain roll was now limited to use in section and bar mills, sometimes for cogging, more often for roughing and finishing, where a large range of section was produced, and outputs required at one rolling did not justify harder alloy rolls. A small percentage of chromium was usual and the hardness ranges from 35 to 40 deg. Shore. This type of roll was strong and tough and had good resistance to firecracking.

Alloy grain rolls varied in surface hardness from 40 to 60 deg. Shore. Nickel, chromium and molybdenum were the principal alloys used. High-alloy rolls were more liable than grain rolls to firecracking. It was essential with this type of roll to keep the surface at as low and as even a temperature as possible, by proper distribution of cooling water fed independently to each roll. In the United States the greater tonnages and longer runs possible with less changing of rolls, and the use of special mills for one type or a limited range of sections, created an earlier demand for high-alloy rolls, with the result that their mill practice had been adapted to suit the new types of roll to a greater extent than was yet possible in this country.

Straight carbon and low-molybdenum alloy chilled rolls form the largest proportion in tonnage and numbers of chilled rolls made. Surface hardness is from 55 to 65 deg. Shore. These were still the most suitable types of roll for hot rolling steel plates, sheets and black plates in two- and three-high single mills. They would stand rougher use under conditions of shock load and heat than was possible with any of the harder alloy chilled rolls. Controlled heat of the material and of percentage reduction, preheating of rolls and control of roll working temperature had greatly reduced casualties and increased average life, but the best conditions in these mills were very severe.

High-alloy chilled rolls are made with surface hardness up to 90 Shore. Again the alloys used were nickel, chromium and molybdenum. For hot rolling the use of alloy chilled rolls was limited to small sizes for strip and light sections, and to applications where they could work within very close limits of temperature. They could be surface-ground to a high polish and for cold rolling of flat work they gave a degree of finish impossible with the ordinary chilled roll.

Hardness

The scleroscope-hardness test had become a standard method of measuring the surface hardness of rolls and an important part of the specification for rolls for special purposes. The difference on British and Continental instruments was as high as 12 points. Further, machines of the same type did not always give equal hardness readings on the same surface, even when they agreed on the standard test block. There was a pressing need for standard chill blocks covering the full hardness range of instrument for roll hardness, if specifications were to be checked satisfactorily.

Science and the knowledge derived from scientific research had been largely responsible for the great progress made in works practice during this century.

Cast-Iron Surface Plates and Tables

The British Standards Institution has recently issued the first of the British Standards in its programme of work relating to Engineers' Precision Tools, *viz.*, No. 817, which refers to cast-iron surface plates and tables for inspection and marking purposes. The specification deals with surface plates up to 15 ft. diagonal length, and two types of surface tables from 5 ft. to 15 ft. diagonal length. Some general features relating to design and essential dimensions are laid down and a schedule of standard sizes with minimum thicknesses and overall depths is incorporated. The primary object of the specification, however, is to prescribe standards of accuracy, and these are comprehensively dealt with for four grades of finish, namely, two qualities of scraped finish and two qualites of planed finish. These standards of accuracy have been adopted in close collaboration with the National Physical Laboratory, and in addition to standards of flatness over the whole plate and over local areas, standards are laid down for the percentage of bearing area. Copies of this British Standard No. 817, may be obtained from the Institution, Publications Department, 28, Victoria Street, London, S.W.1. (Price 2s. 2d. post free).

The Casting of Steel

PROFESSOR ANDREW'S PRESIDENTIAL ADDRESS TO SHEFFIELD FOUNDRYMEN

The opening meeting of the Sheffield Branch of the Institute of British Foundrymen, over which Mr. J. Roxburgh presided, in the unavoidable absence of Mr. J. B. Allan, was devoted to the Address given by the newly elected President. This session the occasion was noteworthy, as the Branch had been fortunate in securing Professor J. H. Andrew, B.Sc., as the President. The subject of his address was "The Casting of Steel."

MR. J. ROXBURGH, introducing the new President, said Professor Andrew was well known both in this country and internationally as a distinguished scientist. The members all knew of his work at the University, and what pleased them particularly as industrialists was the fact that, as the Dean of the Metallurgical Department of the University, he had taken a great interest in Sheffield's industrial activities. It gave him very great pleasure indeed to ask Professor Andrew to occupy the Presidential chair this session. They all wished him a successful year and knew full well that he would undoubtedly bring great credit and distinction to the Branch.

The Professor then gave his Presidential Address, in the course of which he said:—

MR. ROXBURGH AND GENTLEMEN,—

In the first place, I should like to thank you for the honour you have done me in electing me as your President for the year, and you may be assured I shall do all that is in my power to further the interests not only of this Branch, but of the Institute as a whole.

As I am naturally regarded as an academic man, it would be unwise for me to speak to you on the more practical problems associated with foundry operations, with which you are more familiar than I am myself. I must ask you therefore to bear with me in listening to a somewhat scientific exposition.

Experiments on Fluidity

It is well known that, at the University of Sheffield during the past year or two, the staff have been carrying out experiments concerned with the fluidity of carbon steels with varying carbon content and a number of special alloy steels in which the carbon remained constant and the alloying elements alone varied. To my mind, the most interesting features of these experiments were:—

(1) The fact that we were able to devise a type of mould which gave results very closely in agreement when repeated tests were taken.

(2) The fact that the diagram correlating fluidity, as measured by length of spiral, showed an extraordinary correspondence between not only the points on the liquidus curve, but also the changes in the solidus region. This would indicate that the solid state is in some way dependent upon the liquid state from which it is formed. This in itself suggests that in the near future metallurgists will have to study the constitution of the liquid state. One of the difficulties that arise in studying the liquid state by means of X-ray or electron diffraction experiments is the difficulty of keeping the surface of liquid absolutely still and devoid of motion.

(3) If the temperature at which the fluidity is sufficient to give a spiral of a certain and constant length—we selected a length of 12 in. in our experiments—be noted and one plots these temperatures against composition, then the curve obtained is of very similar shape to the liquidus curve of the system under examination, which again points to the fact that the fluidity of a system of alloys is very closely related to its constitution.

The work on alloy steels so far accomplished shows that alloying elements added other than in considerable amounts had no appreciable effect on the fluidity and that the all-important factor was temperature. In the discussion of a Paper published three years ago in the Journal of the Iron and Steel Institute, Dr. Sarjant suggested that the evolution of gases from the steel in the molten condition may have an appreciable effect on the fluidity. I strongly agree with this contention, and it may be that the reason why foundrymen find what they imagine to be large differences in fluidity under different conditions of melting, may be due either to the evolution of gases or to the actual gas content of the steel in question.

Gases in Steel

Metallurgists are now realising that gases may play a very important part in steel. My department is at present undertaking an investigation on the casting of steel in relation to casting temperature, form of deoxidiser used and other variations in practice, and it is fully realised that the question of gases has to be kept in the forefront in considering these experiments. Whilst it does not do to prophesy, my colleagues are more hopeful of being able to eliminate blowholes to a large extent by the addition of iron nitride to the molten metal. It is obvious that the nitride will have to be added in such amounts that no iron nitride is left in the steel. If, however, by this means the steel can be, so to speak, cleaned of other gases by nitrogen—Dr. Swinden and others have found that this gas is extremely effective in obtaining a sound ingot—it would seem to be a very obvious and easy means of getting the nitrogen into the molten steel. Other questions which require careful study are the effect of adding not only different deoxidisers, but of the time between adding the deoxidisers and the pouring. From the small amount of work already done, this factor appears to be more important than we had at first thought.

The University is also undertaking experimental work on the casting of long bars with a view to obtaining information with respect to the effect of the sand on producing hot tears. These long bar castings, I understand, are apt to develop hot tears, and the reason is as yet not fully known, but it is suggested that they are due to what might be termed some dragging action of the sand. Viewed from another angle, however, it would seem obvious that unless a bar of this character solidified simultaneously as a whole, a tear would be bound to result, for as steel solidifies it immediately contracts, and unless the metal which is up against this solidifying portion is sufficiently fluid to make up for this contraction, a tear is bound to result. Indeed, the ideal condition is that a casting, however complicated, should solidify as a whole simultaneously at a constant temperature; the possibility of avoiding cavities would then seem to be remote.

Iron-Sand Moulds

I have been carrying out some interesting experiments using, instead of ordinary moulding sand, a composition composed of iron filings or small turnings mixed with just sufficient sand to bind them together. It has been found that a strong mould could be made with material containing as much as 90 per cent. of turnings and that this acted as a mild chill, producing in certain irons a white condition, whereas under normal sand casting that iron would be grey. This method might usefully be employed instead of ordinary chills, for it would enable moulds to be built up differentially of ordinary sand and also material containing a high percentage of turnings just at those places where rapid cooling was desired. The chilling effect of this "iron sand" could be varied very considerably by the degree of tamping. If a considerable pressure is used so as to increase the density, the chilling effect is increased enormously, whereas by light tamping the chilling effect can be reduced to almost that of normal sand. If a more conducting metal, such as copper or aluminium, is used, the chill produced is even greater. I should very much like to see this system tried out in practical foundry operations, for it might be of considerable service to the industry.

Complexity of Cast Iron

Another feature which practical foundrymen do not recognise sufficiently in relation to cast iron is the effect of such elements as silicon, phosphorus and manganese. Silicon and phosphorus, when in solution in relatively small amounts, retain the iron in the alpha state at all temperatures, whereas manganese tends to retain the iron in the gamma condition. It is quite possible therefore that carbon, which will only dissolve to any appreciable extent in gamma iron, will distribute itself preferentially even at a high temperature, the silicon and phosphorus-rich areas containing little or no carbon, whereas the high-manganese areas will contain the greater part of the carbon. One might even ask whether such a condition also might not pertain in the liquid state and that graphitisation may be due to this cause. It is well known that carbide-forming elements such as chromium do retain the carbon in the combined state; but why nickel, which is a gamma retaining element, should also act as a graphitiser is not easy to understand, unless it be that nickel forms, at high temperatures, a carbide which breaks down on cooling.

A metal like cast iron, containing as it does so many elements, is naturally complex, and it must be regarded as a heterogeneous conglomerate built up of different elements differently concentrated at all temperatures, in which each phase undergoes a different reaction during heating and cooling. Metallurgists can only deal scientifically with systems containing at the most three elements, and when one is concerned with a material containing iron, carbon, manganese, silicon, sulphur, phosphorus and, maybe in addition, nickel and chromium, all that the scientist can do is to suggest a reason for the complications that arise, and leave it at that.

Practice Should Reinforce Science

I am strongly of opinion that the only way in which foundry science can develop on sound lines is for the practical man to interest himself more deeply in the scientific aspect. Those who are conducting researches in a University or other research institution can only confine themselves to a small phase of foundry practice in general. If, however, those who are making castings day by day would interest themselves sufficiently in the scientific side, as any peculiarity cropped up, they would have the knowledge to offer an explanation and, being in the position to collect such an enormous amount of data, they would soon accumulate sufficient to enable them to put forward a theory, the truth of which no one could deny. The amount of work published is infinitesimal compared with the amount of work that is done daily, and workers in industry are in a unique position to further the progress of foundry science far more than is the case with the scientific worker.

It is for this reason that those who take the time and trouble to pursue a full course in foundry science at a University and then associate themselves with industry are in such an admirable position to further the science of founding, for, as I have already said, not only have they access to a large amount of data, but they are collecting fresh data every day during their working hours, and it is, I am convinced, only by the application of true scientific methods and by thinking along scientific lines that any great progress in foundry science can be made.

DISCUSSION

Use of Aluminium

MR. T. R. WALKER (hon. secretary) said that he had been very interested in what the President had said. He did not see entirely eye to eye with the President when he said that the change in fluidity in steel was due almost entirely to changes in temperature. He would agree that in a single cast the change in fluidity was mostly due to changes in temperature. As to casts of the same composition, he would agree again that temperature largely determined their fluidity, providing that the term " composition " included everything in the steel. Most people, however, when talking about casts of similar analysis, did not include consideration of oxygen and other gases, or the presence of small amounts of aluminium. In the foundry with which he was connected, the method of manufacture of steel in basic electric furnaces did make a difference to the fluidity, even when the apparent casting temperature, and the analysis of the steel for the ordinary elements, were almost exactly the same. In some cases they did get steels which could be made very hot and were apparently fluid, but they did not run very far. In this particular foundry aluminium was invariably added to the steel. He thought that aluminium was a very good friend in a foundry or in steel melting generally, but that it also was a bad enemy if added in excessive amounts. The tendency in foundries and steelworks was to add a fixed amount of aluminium, whether any particular cast needed it or not. The introduction of aluminium into steelworks had been responsible for excusing a great deal of bad melting. Some Papers had recently been published, especially in America, suggesting that aluminium was partly responsible for low ductility in steel castings. Did the President think that this loss of ductility was due to the aluminium, and, if so, in what form was it particularly deleterious?

Various Influences at Work

The PRESIDENT replied that they had to use exactly the same type of mould to compare the metals. Some metals did run quickly and became solid quickly. With a high-conducting mould they would naturally find some difference in fluidity. Gases were, as he had said, of importance in considering fluidity. If they passed nitrogen through steel, a casting could be obtained devoid of blowholes. They had to consider the effect of gases, because he was convinced that the gaseous inclusions, which must be different according to different methods of manufacture, would make a difference in fluidity. If the steel was made in the same furnace and the fluidity was different, he thought this might be due to a different gas content.

With regard to aluminium decreasing fluidity, he would expect that; some of it might crystallise around the grain boundaries, and that would give a low ductility. He did not like any element which had a high oxidation coefficient. When it remained in the steel, it might give rise to low ductility.

MR. WALKER said that some time ago Papers were published in America regarding alloys such as ferro-chromes in which the content of, for example, nitrogen was purposely made high. It was claimed that such alloys produced remarkable properties in the steel, and he would be interested to learn if the President had had any experience in this direction.

The PRESIDENT said that nitrogenised chrome was said to give much better cutting properties than ordinary chromium when used for making high-speed steel. It was very difficult to retain nitrogen in pure iron in the molten condition, but the ageing effect of the nitrogen was phenomenal. If they nitrogenised steel and quenched it from 650 deg. C. and allowed it to remain at atmospheric temperature, the maximum stress would increase enormously. The hardening effect produced by nitrogen was likewise very considerable.

Co-operation Between Foundry, Drawing Office and Machine Shop*

By Dr. Ing. H. JUNGBLUTH

The co-operation between foundry, drawing office and machine-shop is a familiar theme. The method generally adopted in dealing with the problem is that guiding principles are established, particularly by the foundryman, by means of isolated examples giving the points of view to be taken into consideration in the design of castings in order to permit satisfactory casting of constructional elements. It is not the purpose of this Paper to add to the number of the existing examples which have been given by the best qualified authors, but rather to contribute a few ideas of a general nature on the subject.

It would appear necessary in the first place to ascertain what should be the scope of the co-operation between foundry, drawing office and machine-shop. It seems to the present author that this is governed by the following three points of view:—(1) Choice of suitable material; (2) correct design from the point of view of casting, and (3) correct design from the point of view of machining. These points will be discussed separately, and the position already attained in Germany will be described as far as it is known to the author.

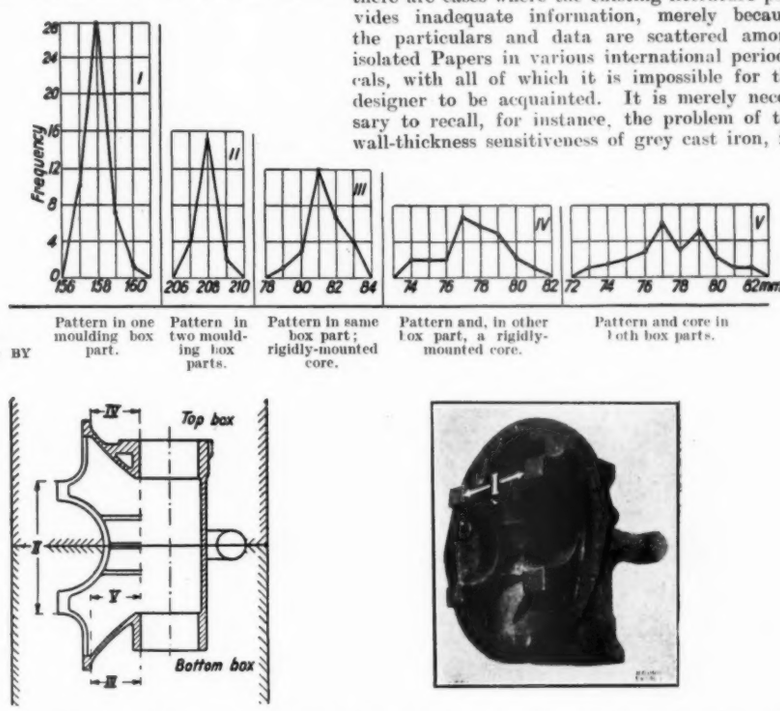


FIG. 1.—DIMENSIONAL VARIATIONS IN A BACK-AXLE CASTING (ACCORDING TO O. HENGSTENBERG).

The dimensional variations are scattered in the form of statistical frequency curves, but in different amounts according to the place of measurement.

Choice of Suitable Material

It is assumed as a matter of course that the designer is quite clear about the nature of the stresses which the machine component he is designing will have to withstand, whether he calculates or estimates them on the basis of previous experience. There are in Germany a number of handbooks and publications providing a general review of the subject from which the designer can form a general idea as to the materials coming into consideration.

On looking through such books and Papers, it will very soon be found that in many cases they are inadequate; nor can they be otherwise, for the subject they are dealing with is far too wide for them to offer any more than mere hints. This is particularly the case in critical fields not concerned with mechanical properties alone, *e.g.*, in the case of heat- and acid-resisting castings. In this connection, the catalogues and pamphlets published by manufacturing firms provide more information, but even they generally fall short of what is required.

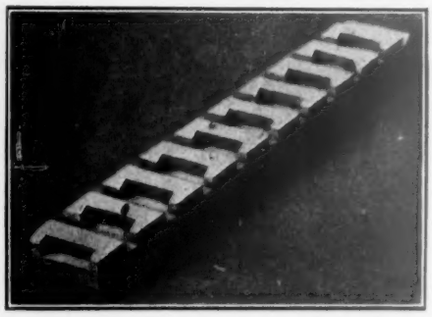
Even in apparently simple fields, for instance, that concerning questions of strength alone, there are cases where the existing literature provides inadequate information, merely because the particulars and data are scattered among isolated Papers in various international periodicals, with all of which it is impossible for the designer to be acquainted. It is merely necessary to recall, for instance, the problem of the wall-thickness sensitiveness of grey cast iron, its damping properties, notch effect and so forth. In the field of special cast steels, there are alloys having special electrical and magnetic properties, often accompanied by outstanding mechanical properties which also cannot be enumerated in the handbooks. Such examples could be increased indefinitely. In these cases, it is essential for the designer to make direct contact with the foundry experts on materials. As these specialists make it their sole business to study problems concerning materials, they have as a rule a far greater experience than even the largest engineering works. In particular they know what information is required in order to decide upon the materials to be employed in a given case. It would certainly be unwise not to make use of this source of information.

Correct Design from the Foundry Angle

In general, it is necessary to distinguish between design from the points of view of mould-

* Official German Exchange Paper of the Technischer Hauptausschuss fur Giessereiwesen to the Polish International Foundry Congress

ing, of casting and of cleaning. As mentioned above, this Paper is not intended to add to the already abundant examples given in the literature, the author's opinion being that this would not make the subject any clearer. It must in fact be borne in mind that, just as in the literature dealing with materials, the general rules for design together with examples can only indicate the general direction which design should take. The rules have frequently to be broken, either in actual fact or apparently, and this unfortunately does not exactly help to make the position of the foundryman and designer any clearer. In this case also, direct contact between foundryman and designer is indispensable, in many, if not in most cases.[1]



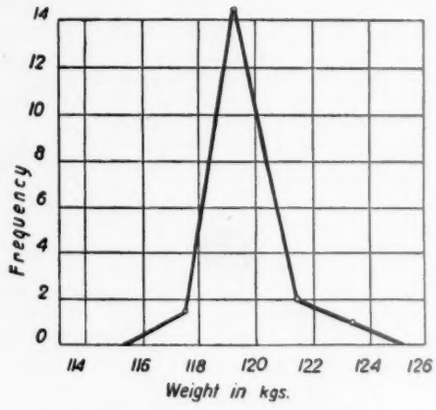


FIG. 2.—STEP GRATE. DEPENDENCE OF THE VARIATIONS IN WEIGHT ON THE SHAPE. (O. HENGSTENBERG.)

Reference may be made at this point to a difficulty which often gives rise to misunderstanding between the designer and foundryman. The designer generally thinks that the foundryman knows so much about the casting of parts of machinery and apparatus that all that is necessary in order to obtain from him a binding proposal for a design suitable from the point of view of casting is to hand the foundryman a drawing with a request for his comments within 24 hrs. Unfortunately, this is not the case. Even the foundryman will sometimes be obliged first to try out various methods of gating and moulding before he can give any definite views regarding design.

It will be seen from the "Konstruktionsregeln für Grauguss" (Rules for the Design of Grey Iron Castings), by R Lehmann,[2] how indefinite and general they must be if they are to mean anything at all. When the designer makes additional demands, not always clearly expressed, such as the adherence to a certain maximum weight, refusal to allow reinforcements and stiffening ribs for constructional reasons, refusal to allow the use of chaplets, chills, etc., matters become still more complicated. All this goes to show how essential is personal contact between designer and foundryman in this case also and how essential it is to have an adequate understanding of the points of view of both sides in order to arrive at satisfactory results. Impatient designers have repeatedly expressed the opinion of wanting to desert "unreliable" castings and to go over to "reliable" forgings; yet, whatever one may think about castings, they will still be produced, it being quite impossible to do without this process in engineering construction.

Correct Design from the Machining Angle

A particular source of trouble between the foundry and the engineering works is the question of design which is suitable from the point of view of machining, since it comprises the question of the dimensional accuracy of the casting. In the author's opinion, this is due to the absence of any clear notion of the categories of castings which may be distinguished from the point of view of the problem under consideration. There are three of these categories, namely:—(1) Rough castings; (2) castings for repetition work, and (3) castings ready for assembling.

It can be required of the rough casting that the component is "contained" in the casting and that the machining allowance is not greater or less than a certain, usually-ample amount. The machining process in the workshop then generally consists of marking out the casting, fixing the punch marks and distributing the machining allowance as evenly and as favourably as possible. The principal field of application is that of single castings where one, or at the most only a few, castings are made from a pattern, and where this rather troublesome method is profitable.

Castings for repetition work are expected to satisfy more stringent requirements. The component must not merely be "contained" in the casting, but, in addition, it is expected, unfortunately not in so many words but tacitly, that the casting should fit the "jig" of the machine tool without previous marking out, and should be capable of immediate machining. Even if the component is comprised in the casting, the latter may be rejected if it does not fit the jig or fixture.

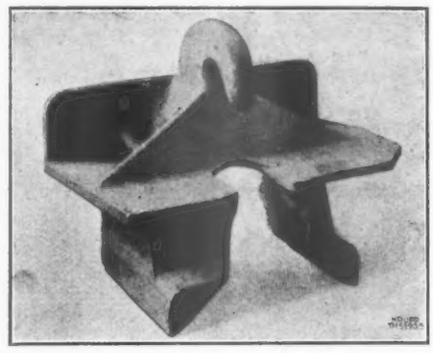
Castings ready for assembling, such as are required, for example, in various agricultural machines, are expected to comply with still severer requirements. Such castings have to be a direct fit and be capable of assembly without machining.

The following may be stated in detail with regard to these three types of casting:—

As a rule, rough castings give rise to the least difficulties between foundry, drawing office and machine shop. It is very rare that a component is not "contained" in such a casting. It is checked in the machine shop and the optimum machining conditions are thus necessarily found.

The position is different with "castings for repetition work." O. Hengstenberg[3] has recently published a Paper of fundamental importance which should certainly arouse the interest of foundryman, designer and machine-shop foreman alike. It will be adhered to very closely in the following.

The designer already provides certain "spotting points" or "working surfaces" by means of which the casting is to be applied to the machine-tool jig or fixture and from which all the dimensions should be correct if the casting has been machined satisfactorily at all points. It is obvious that these points should be indisplaceable, and should not be affected by the moulding methods adopted. Unfortunately, their position is determined from the combined points of view of foundry practice, design and machine-shop practice, and this again gives rise to friction between foundryman, designer and machine-shop foreman. It may happen, for instance, that spotting points for ensuring a certain spacing or distance are provided by the designer on faces which the foundryman must necessarily cast in the core. When cores are inserted, however, despite the most meticulous care, displacements on the plus or minus side are unavoidable, and therefore such location points are generally bound to give rise to inaccuracies. In such a case, co-operation between the designer, foundryman and machine-shop foreman is essential for discovering suitable location points. On the other hand, cases are possible where core surfaces must be used for location points. Each individual case must therefore be considered



In bulky articles the scattering of the variations in weight is greater than in simple articles.

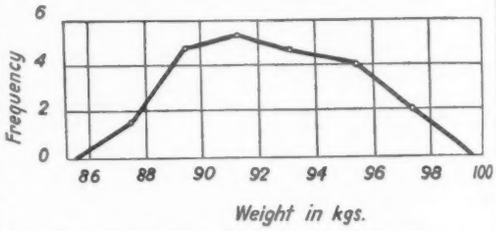


FIG. 3.—BUFFER ROD GUIDE. DEPENDENCE OF THE VARIATIONS IN WEIGHT ON THE SHAPE. (O. HENGSTENBERG.)

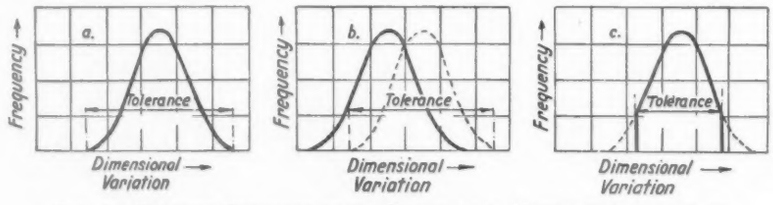


FIG. 4.—POSSIBLE POSITIONS OF THE DIMENSIONAL VARIATIONS RELATIVELY TO THE PRESCRIBED TOLERANCE. (ACCORDING TO HENGSTENBERG.)

1 In the introduction to the joint work by A. Thum and K. Sipp: "Das Werden des Gussstückes in konstruktiv gestaltlicher und giesstechnischer Beziehung" (The Formation of the Casting from the Point of View of Design and Foundry Practice), K. Sipp says: "It does not appear possible to train the designer to enable him to acquire, in addition to his engineering knowledge, also a knowledge of foundry practice to the degree necessary for solving all his design problems, and the attempts which have been made with this end in view must all be regarded as having failed in their object. We therefore necessarily come to the conclusion that the designer must seek the aid of an assistant to advise him on foundry matters and that assistant is the foundryman."

2 "Konstruktionsregeln für Grauguss." "Giess.," 14 (1927), pp. 701–705, etc.

3 Techn. Mitt. Krupp, 5 (1937), pp. 221 to 225; see also Masch. Bau "Der Betrieb," 16 (1937), pp. 365 to 367.

on its own merits to ascertain the points or surfaces which are suitable for this purpose.

When agreement has been arrived at with regard to the spotting points and faces, it is then necessary not to go below or above certain dimensional tolerances, it being, of course, impossible to produce an entire casting "to size," some of the reasons for which are enumerated by O. Hengstenberg. Also the accuracy of the casting may not be the same all over, as has been shown by this author with the aid of statistical frequency curves,[4] an excellent example of which is reproduced in Fig. 1. With the aid of two further examples, reproduced in Figs. 2 and 3, which are self-explanatory, he shows the extent to which the variations depend upon the shape of the casting. These comments clearly indicate that attempts to establish generally binding data regarding tolerances are doomed from the outset to have relatively poor chances of success. When, therefore, in the "Handbook of Materials, Steel and Iron,"[5] H. Korschan and O. Hengstenberg give in a numerical table "Indications of the order of magnitude of the dimensional variations usual in the most important shaping processes for unalloyed or low-alloy steel," it should be emphasised with regard to the figures given for castings that they are also

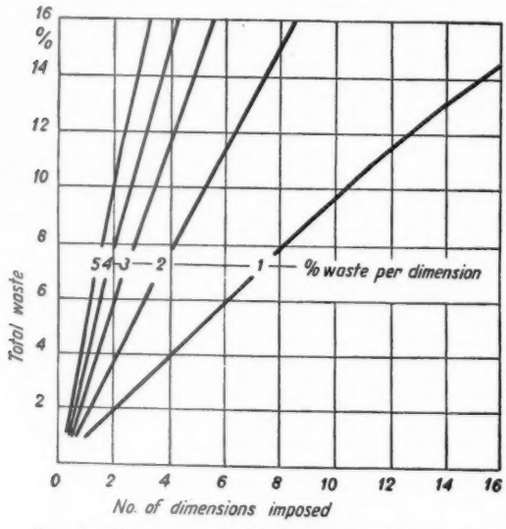


FIG. 5.—INCREASE IN WASTE WITH NUMBER OF PRESCRIBED DIMENSIONS.

For example, four dimensions each of which singly causes 3 per cent. of waste, produce altogether 11.82 per cent. of waste. (According to O. Hengstenberg.)

referred to by the authors themselves as "indicative figures" of the "order of magnitude" of the dimensional variations.

Hengstenberg also indicates a method of applying frequency statistics to the solution of the problem of dimensional variations, at least in the case of mass-production, by co-operation between the designer, foundryman and machine-shop foreman. In this case, also, reference may be made to his method of representation reproduced in Fig. 4. There are three possibilities for the position of the dimensional variations relatively to the tolerances.

In case *a*, the dimensional variations agree in magnitude and position with the tolerances and production is in order. Checking the castings by the foundry or customer can be confined to random tests.

In case *b*, the magnitude of the variations (solid-line curve) corresponds to the tolerance (dotted-line curve), but the variations are mainly of minus value and to a considerable extent are less than the minimum dimension. The defect can easily be remedied by modifying the pattern.

[4] See in this connection, for example, K. Daeves: "Praktische Grosszahlforschung" (Practical Statistics), Berlin, 1933, and O. Hengstenberg, Techn. Mitt. Krupp, 1 (1933), pp. 112 to 117.

[5] "Werkstoffhandbuch Stahl und Eisen" (Handbook of Materials, Steel and Iron), Verlag Stahleisen G.m.b.H., Düsseldorf, 1937, 2nd Ed., A. 120 to 126.

In case *c*, conditions are much more serious. The required tolerance is obviously too small for the accuracy attainable in the foundry. Generally a bitter dispute then commences, either because the foundry is disbelieved when it says that greater accuracy cannot be secured or because the foundry has really not done everything to ensure maximum accuracy. There is then, unfortunately, again much arguing at cross-purposes because there are no specified terms which are essential for coming to a decision. As a matter of fact, the foundry sometimes quotes binding prices based on methods of moulding which allow only a moderate degree of accuracy. Later, however, the workshop demands degrees of accuracy requiring more expensive methods of moulding, but is not prepared to agree to an increase in the quoted prices. This dispute has to be settled again and again, and there is scarcely any criterion for an impartial decision. When the two parties finally come to an agreement, each of them has the feeling of having had to submit to a forcible peace. If, in the case *c* mentioned above, the tolerances cannot really be increased, production is only possible by the method of selection. Each casting must be measured up, and those falling outside the tolerance must be rejected.

In commencing the mass-production of articles (for instance, cast motor-car accessories), after a preliminary agreement has been arrived at between the designer, foundryman and machine-shop foreman regarding the form of the castings, a not too small number of castings will be made in order to ascertain by means of frequency statistics in which of the three cases *a*, *b* and *c* the dimensional variations observed are included. The treatment of cases *a* and *b* is simple. With *a* it is possible to commence production at once, and with *b* the pattern must be modified until the dimensional variations are correct. In case *c* the discussions outlined above must be commenced. It should also always be borne in mind that excessively narrow tolerances always mean higher costs. What is perhaps saved in machining is added in casting by the considerable waste (selection principle) or more expensive working methods. Furthermore, Hengstenberg points out that the total waste indubitably increases with increasing number of the prescribed dimensions, and he shows this by means of a diagram (Fig. 5).

Generally, the construction of the gauges necessary for measuring and the jigs or fixtures necessary for machining go hand in hand with the design of the castings. For the regular case this is as it should be. In the case of complicated mass-production castings, Hengstenberg recommends fixing the tolerances and constructing the special gauges and jigs or fixtures only on the basis of the dispersion or scattering of the dimensional variations as ascertained from frequency curves of test castings, instead of conversely by adapting the castings to the gauges and machining jigs or fixtures by modifying the patterns and casting methods.

It should really be obvious that the spotting points of the gauges and jigs or fixtures should agree, but the author is aware of occasions where this was definitely not the case. In such circumstances, disputes between foundry and workshop are unavoidable. This also occurs when the foundry is supplying two firms with the same component but the firms are using different jigs or fixtures, cases of which are likewise known to the author.

For "castings ready for assembly," conditions are similar to those of castings for repetition work, because in many cases when inquiries are made or orders given for castings, it is not definitely stated that a casting ready for assembly is wanted. If this is clear, however, conditions are simple, as the entire examination of the castings is the concern of the foundry alone, which then prepares the castings for assembly (drilling out holes, straightening the castings in the case of malleable iron castings, etc.). Disputes can then only arise when it is a question of the magnitude of the tolerances to be observed according to case *c* of Fig. 4. Dimensional variations also occur, of course, with castings ready for assembly because the castings are not machined. These disputes should then be dealt with as in the case of castings for repetition work.

In conclusion, it can undoubtedly be said that, considering the high demands which engineering has to put nowadays on the castings employed, a satisfactory all-round result is only to be expected if there is close co-operation between the designer, foundryman and machine-shop foreman, because such requirements have become so numerous and varied that the individual can no longer grasp all of them, and only collaboration can lead to the desired result.

World's Production of Nickel Ore in 1937

The subjoined table, which is extracted from the Statistical Summary (Production, Imports and Exports), 1935-37, issued by the Imperial Institute, shows, in tons of 2,240 lbs., the world's output of nickel ore in terms of metal, in 1935, 1936 and 1937, for the principal producing countries.

Producing country.	1935.	1936.	1937.
BRITISH EMPIRE.			
Southern Rhodesia (est.)	12	14	2
Canada	61,838	75,777	100,404
Burma†	1,465	1,292	1,200
Total	63,300	77,100	101,600
FOREIGN COUNTRIES.			
Germany	268	*	*
Greece‖	1,091	1,235	*
Norway	1,216	1,251	863
U.S.S.R.	1,800	*	*
Egypt	—	—	14
Morocco (French)	205	146	250
United States§	143	96	196
Brazil	5	470	102
New Caledonia‡	8,100	4,820	6,600
Total	12,800	10,000	11,500
WORLD'S TOTAL	76,100	87,000	113,000

* Information not available.

† Nickel content of speiss obtained as a by-product in smelting operations.

‡ Estimated content of matte and ferro-nickel obtained at smelters was as follows:—1935, 6,000 long tons; 1936, 4,650 tons.

§ Nickel content of salts and nickel produced as a by-product in the electrolytic refining of copper (partly from imported blister copper). Secondary metal was recovered in the United States as follows:—1935, 1,750 long tons; 1936, 1,754 tons; 1937, 2,143 tons.

‖ Figures represent combined totals of nickel content and cobalt content of ores.

Calendars Received

The calendars noted below arrived too late to be acknowledged in our last issue. We are indeed grateful for them and reciprocate the good wishes which accompanied them:—Hargreaves Brothers, of Salford: A monthly tear-off wall calendar. H. Hendra & Son, Croydon: A monthly tear-off wall calendar surmounted by a coloured picture of a bathing belle. W. & J. F. Jones, Limited, Pendlebury: A monthly tear-off wall calendar surmounted by a picture, printed on silk, of a very charming Victorian child. Smith & Fawcett, Bradford: A monthly tear-off wall calendar carrying on the upper half pictures of the foundry and its equipment and products.

Education for Foundry Personnel

DISCUSSION IN LONDON

The members of the London Branch of the Institute of British Foundrymen had an appropriate rendezvous on January 4, at the Sir John Cass Technical Institute, Aldgate, E.C.3, for the discussion of the problem of education for foundry personnel, having regard to the great work of the Technical Institute in educating personnel concerned with foundries, ranging from metallurgists, chemists and University graduates engaged in research to the foundry apprentices. Mr. C. C. Booth, J.P. (the Branch President), was in the chair, and he was accompanied by Mr. George Patchin (Principal of the Sir John Cass Technical Institute), at whose invitation the meeting was held in the Institute.

Papers were presented by Mr. A. F. Gibbs (Demonstrator at the Sir John Cass Institute, and a Past-President of the London Branch), and by Mr. L. Singlehurst-Ward (Head of the Metallurgical Department of the Sir John Cass Institute). These Papers are given below.

ASPECTS OF EDUCATION IN RELATION TO THE FOUNDRY

BY A. F. GIBBS.

On this very much debated question of education in relation to the foundry worker, a full sense of inadequacy is felt by the author. Notwithstanding this, it is a pleasure to make an effort on behalf of the trade and this Institute. Owing to the rapid strides made during recent years in the new technique in foundry practice, it is thought that the craftsmanship and pride associated with the moulding and production of difficult castings are being lost. Different authorities are to be heard lamenting the fact that the young craftsmen are not coming forward to-day in sufficient numbers to replace the old ones. Due to specialisation and mechanisation the industry is to a large extent losing that very fine asset, the all-round craftsman who could tackle and finish practically any type of job, and perhaps, what is more, produce a good casting at the first attempt. Numerically speaking, it is not losing but rather gaining craftsmen. The machine-moulder, who can efficiently operate a machine continuously and produce castings at least equal to what were formerly turned out by hand methods, is a craftsman in the true sense of the word and he should be deemed a mechanic as much as the man who operates a boring or a slotting machine. There are some really skilled coremakers and some really wonderful work is being effected by female labour. Although progress through education, specialisation and mechanisation has displaced some types of craft, it also has created other skilled craftsmen.

Key Positions

With the big strides industry is now making, everyone will agree that "key men" must be more than the equal of their predecessors 20 or 30 years ago. Gone are the days when a man could talk his way into a position by hinting at the secrets contained in his private notebook, and with him has disappeared the travelling vendors of quack nostrums guaranteed to turn inferior metal into metal of high quality. If any man aspires to progress in the foundry profession, he must know his work very thoroughly and be able to "produce the goods." This is where the practical man will find the value of some technical knowledge.

Does the young foundry employee appreciate the opportunities offered him for pursuing such studies as are provided for his benefit? Superficially the answer is "no," but after mature consideration one wonders if the lads and young men are getting the encouragement they ought to receive. Various firms are doing splendid work by providing classes for their foundry apprentices, whilst others in the London district are offering to pay evening-class fees. But are the members of the Institute of British Foundrymen backing up these efforts? How many have even recommended one young man to pursue evening studies, although, when the scheme now in operation was introduced some seven years ago, the members were asked to co-operate by bringing forward to the notice of apprentices and junior employees the advantages of such a scheme? There are students who, having taken up classes under facilities, have, owing to a so-called rush of work, been refused the evening off by their foreman. Others who have been granted permission to leave an hour earlier are occasionally retained by the foreman until six. Thus apprentices sometimes arrive at the Institute without having had a meal or having changed into other clothes. The managers and foremen no doubt hold the key to the question as to whether the educational authorities are turning out those who will be able to take real responsibility.

Whilst it is not desired to detract from any of the opportunities offered to the apprentice, it is suggested to those employers who are broad visioned on this question of education that they extend these privileges for the first year at least to include the young moulder, coremaker and patternmaker whose ages may range up to 30 years. Teaching experience extending now for over fifteen years has indicated that the most persevering and promising type of student is derived from these young men. Perhaps this is because these young men—mostly married—have acquired added responsibilities, and realise the desirability of improving their knowledge and their own position, whereas quite often the young apprentice too readily finds the task of studying a little irksome, especially after a hard day's work in the foundry. Possibly some employers imagine that as soon as this type of man has gained experience, he will leave their employ, and some other firm would reap the benefit; this is a very short-sighted policy, because in these days of national co-operation practically all improvements in technique and knowledge are to-day virtually broadcast for every one's benefit.

Will Education Make Better Craftsmen?

In the majority of cases it certainly does. Of course teachers do sometimes run up against students who, after two or three attendances, think they cannot learn anything more from the course arranged. Not a single student studying under the author has been successful in improving himself or his position, through simply listening to lectures or watching demonstrations. To accomplish these things he must supplement evening study by a strong determination to succeed; he must read for himself and be prepared to sacrifice some pleasures. Once he has started to accumulate technical knowledge, he will begin to realise how little he knows of some of the things that matter, and for this reason alone anyone in this state of mind has at the very least improved his outlook.

Educational Success and Improved Positions

Will success in evening classes guarantee a better industrial position? Obviously this is not necessarily so, as everybody cannot be executives; moreover, some would undoubtedly be more satisfied working in the position of charge-hand, whilst others take a pride in their craft and are fully satisfied with being known as "the best moulder in the shop." This type of man has no wish for the responsibility and worries of an executive position. For the young men, however, who are willing to take advantage of the facilities offered, there is still room at the top.

TRAINING OF FOUNDRY PERSONNEL

BY L. SINGLEHURST-WARD.

During the past twelve years much attention has been given to the training of foundry personnel. Many leaders and articles have appeared in the technical Press and many Papers been read before the members of various societies. A university degree course and a special foundry school have been started, both with the blessing of the Institute of British Foundrymen. Lastly, but not of less importance, an advisory committee of the Institute of British Foundrymen, in co-operation with the City and Guilds of London Institute, was formed to plan a scheme of training leading to a qualifying examination.

A Late Start

Notwithstanding these efforts, much disappointment has been shown in various circles at the results—that is, the number taking advantage of the various schemes of training. It would be very interesting to take a census of those engaged in the foundry industry who could attend courses for further training and those who do so. The blame for this seeming apathy has been variously ascribed to indifference of employers, antagonism of the older hands, specialisation and mechanisation in the foundry, lack of interest by the young employees, type of course and also type of teacher selected, and the most recent suggestion is that the fault lies in the present-day system of primary education.

The author is not of the opinion that the root of the trouble lies under any of these headings, although there may be isolated cases. The opinion is held that the art and science of founding have been kept in the background too long, and now this important branch of technology is coming to the front it is unreasonable to expect results equal to those in other branches of technology which have had perhaps a hundred years' start.

Existing Schemes

To-day training for the foundry is conducted in the following ways:—(1) University courses leading to degrees or diplomas; (2) intensive training at a central foundry school; (3) works training schemes for apprentices; (4) technical institutes and schools. It is not the intention to refer to the first three groups, as they concern a comparatively small or a specialised group of trainees; furthermore, the fourth group is considered to be the most important, as these institutions should meet the demand of the majority of foundry workers.

The author has been for the past 18 years in close contact with foundry training as conducted in this Institute, and wishes now to refer to certain aspects of the training. In the session 1920-21 a course in foundry practice was inaugurated "for metallurgists and those engaged in engineering and foundry work and those interested in the production of all classes of castings"—to quote from the syllabus of that date. From that time until the present the course has always been held, even in the years of the depression, and there is no doubt that this is due to the fact that the course is open to any student who can benefit from it. Although grouped courses are now arranged to suit the requirements of certain examinations, the original purpose still holds, and the student is not compelled to attend such a course. The primary aim in all the work is to train the student. If he wishes to study for a particular examination he is encouraged and every effort is made to ensure his success.

The occupations of the students attracted are very interesting, and also the districts from

which they come. Taking the present and past two sessions, the occupations can be classified as follows:—

Foundry workers (moulders, core-maker, etc.)	31
Foundry workers (assistant-managers, secretary, estimating clerk, etc., including one lady student)	23
Chemists (six foundry chemists) ...	17
Metallurgists (one foundry radiologist)	7
Engineers (one University residential student and one naval engineer)	4

Of this number 15 are graduates.

Schemes of Training in Force

Considering in the first place the young foundryman, if he has received no previous technical training, it is suggested to him that he studies one or two associated subjects before commencing foundry practice, such as: (1) elementary chemistry; (2) elementary physics or mechanics; (3) elementary mathematics, and (4) geometrical and mechanical drawing, but no obstacle is placed in the way to his studying foundry practice at the same time if he so wishes.

It has been found that if he be allowed to commence the study of his own subject, he feels that he is helping himself to progress, and may at the same time realise the benefit of these associated subjects. The maximum number of evenings attendance advised is three, and only then if it is thought the student is capable mentally of such amount of study. It is to be noted that as far as possible these preliminary classes are held in the early part of the week when young students are not tired mentally and bodily by their daily work.

In the second year he should be able to take his place with the student who has received this preliminary training elsewhere, at secondary, central or junior technical school. The subjects now suitable are: (1) foundry practice (continued); (2) mechanical drawing (continued); (3) engineering metals and alloys, and (4) physical metallurgy (1st year). Should he return in future sessions, he has the remainder of the curriculum of the department to choose from, and it has been found that such subjects as iron and steel manufacture, mechanical working, treatment and testing of metals, and metallography and pyrometry are popular.

Courses for Non-Trade Students

The second type of students constitutes, with certain exceptions, those who may be associated with the foundry, but not actually engaged in it. Here, each case has to be carefully considered, except where the student has a definite programme mapped out, which is often the case. These students will study foundry practice for two years on the average, together with a certain amount of metallurgy.

It is not the intention to deal with the practical side, excepting that carried out in the metallurgical laboratories.

Laboratory work is arranged as far as possible to meet the requirements of individual students, the object being that a student shall not perform similar work in the evening to that he does in the daytime. Advanced foundry students may be doing mechanical testing, metallography and even metallurgical analysis and the examination of fuels and refractories. In the majority of cases the students work independently. In one or two cases simple research has been attempted.

Teaching Staff

Some months ago a Paper was read before another local Section, and adverse comments were made against foundry teachers. The foundry teacher must be primarily a practical man of wide experience. It is useless to "talk" if one cannot "do." Deficiencies in the lecture room can be more than counterbalanced in the demonstration. The Institute is very fortunately placed in having as principal teacher one who has many years' experience in both ferrous and non-ferrous foundries and an assistant who is a specialist on aluminium and aluminium alloys.

In nearly every institute he is a visiting teacher; that being so, everything should be done in helping him in his work of teaching a most difficult subject.

Technical Literature

One is rather disappointed in the foundry technical literature—text-books and other publications available at the present time. Text-books are few in number, costly, and contain very often obsolete material even in new editions, and such material they contain is not well balanced. There has been distinct improvement in metallurgical text-books in the past few years, both in price and quality. There is no reason why the same could not be said of foundry text-books.

It is true that such books are costly to produce at frequent intervals; consequently what is new to-day may be four or five years old when a book is rewritten. It is in this field that technical journals can be of value—to give as full an account as possible and as simple as possible of new processes and plant so that even the foundry novice finds the description easy to follow. Speaking of students, some years ago one journal printed a short article for students in each number, but this "students' corner" faded away. To my mind, this was most useful and instructive, and it would be of great value if this "students' corner" could be reintroduced.

DISCUSSION

MR. G. C. PIERCE (Past-Branch-President) agreed that students should acquire a knowledge of English, for a student so equipped was able to take his proper part in discussions of foundry practice. Commenting on Mr. Gibbs' references to the position or qualifications of craftsmen to-day, Mr. Pierce claimed, and said he would reiterate at every possible opportunity until he was convinced that he was wrong, that there were as many craftsmen in the industry now as there were 25 or 30 years ago, and perhaps there were even more, and he used the term "craftsmen" in its best sense. It seemed to have been forgotten that mechanisation of industry had brought in its train the need for a greater number of craftsmen. But he would go some way with Mr. Gibbs in the view that the degree of skill called for to-day is perhaps not so high as formerly. The point which Mr. Gibbs had had in mind, no doubt, was that the foundrymen of the past were artists, and craftsmen at the same time.

Another suggestion he made was that Mr. Singlehurst-Ward had not stressed sufficiently the importance of ensuring that students should not be fatigued at the time they commenced their studies. If it were desired that boys should be trained to become good craftsmen and that they should be able to assimilate the necessary knowledge, it was important to consider whether or not they were in the best condition physically after having worked in a foundry for 8½ or 9½ hrs. In his opinion they were not then in the best physical condition; and although a fair percentage, or perhaps a low percentage, of the young men in the foundry would attend evening classes, the greater percentage of the foundry apprentices would not be attracted to the classes until they were afforded even better facilities than they were currently afforded. For twenty odd years he had tried to persuade boys to attend classes, and had had the privilege of sending some of them to the Sir John Cass Institute; but he had found it difficult to maintain their interest, and their greatest complaint to him was that it was very tiring to attend classes after a day's work. If one studied the apprentices in the foundry one would probably find that that was a reasonable excuse.

A boy should attend classes twice a week, or preferably three times a week, in order to acquire the necessary knowledge if he were to make real progress; but Mr. Pierce looked forward to the time when those responsible in the industry would give the boys opportunities to study during working hours—and those responsible would probably find it to be even more in their own interests than in the interests of the boys themselves. He did not think the difficulty with regard to lack of students in the splendid technical institutes which existed on both sides of the Thames would be overcome until facilities were afforded for the boys to study during working hours.

MR. JACKSON, of Burnham-on-Crouch, suggested it would be an excellent plan to arrange short talks to the young people in the various works on matters concerning the functions of those works, because periodical talks would go far to eliminate working in a mechanical sort of way by inducing a real interest and a desire to advance. The talks should be short and interesting in order to give the young people an interest in the significance of the various processes undertaken.

MR. SINGLEHURST-WARD replied that part-time day courses had been held in certain parts of the country, but, apart from London, he believed that Birmingham was the only place at which they were still being held. The difficulty from the point of view of the foundry apprentices was to secure suitable teachers who could attend during the day. Quite a number of engineers or metallurgists who had had a little experience in the foundry had been prepared to do the work; but employers had felt that was not sufficient and that it was really a waste of time to send the apprentices under such conditions. Birmingham was in a more fortunate position than other centres, for it had two well-qualified foundrymen engaged at the Central Technical College.

With regard to the primary schools, he said that in his Paper he had merely quoted from a leading article in THE FOUNDRY TRADE JOURNAL. One of the laboratory boys in the Department of Metallurgy at one time was trained only at a primary school previously, and had matriculated by attending that school; he had since taken first-class degree honours in metallurgy, and later had been appointed an Inspecting Officer under the Air Board.

MR. GIBBS emphasised his plea that employers should extend educational facilities to their employees up to the age of 30 years; and he added that those who had attained manhood did not tire so quickly as the young apprentices. Part-time continuation classes were very good if they could be provided; but until then he would like to see the young men in the industry encouraged in every other possible way.

A Foundry Club?

MR. K. A. SPENCER said it occurred to him that there was a great gap in the training of the young foundryman, between the technical schools and the Institute of British Foundrymen. It could not be expected, of course, that every lecture arranged by the Institute would interest every section of the foundry industry to the fullest extent. He suggested that that gap between the technical schools and the Institute might well be filled by the provision of a Foundry Club, particularly in London, which club could always be open and could cater for both educational and social activities. In such a club, men in the industry could meet together—and even apprentices would talk about their work when they were together. Such an organisation might be run on the lines of the Cleveland Engineers' Club, and general discussions could be arranged from time to time, at which those attending could refer to any matters which interested them in connection with the industry. Surely the industry in and around London could provide sufficient money for such an establishment.

Expressing general agreement with most of the points raised in the Papers, Mr. Spencer said that founding was gradually changing from an art to a science; founders must equip themselves to meet that change, but at the moment he did not think they were doing it to the fullest advantage.

Are Patternmakers More Expressive than Foundrymen?

MR. GEORGE PATCHIN (Principal of the Sir John Cass Technical Institute) assured the members of the Branch that, when he was asked if they could hold their meeting in the hall of that Institute, he had been delighted to extend an invitation to them; and he hoped that the occasion would not be the last on which they would honour the Institute in a similar manner. As a member of the City and Guilds Institute Advisory Committee dealing with foundry practice, he had always been interested to analyse the examination returns and to note the occupations of those who sat for the annual examinations. In general, it seemed that it was easier for a patternmaker than for a moulder to pass the examinations; and whilst not expressing his own personal opinion on the matter, he said he believed the general view had been that the patternmakers were better able to express themselves than were the foundrymen. Some of the students at the Sir John Cass Institute were well able to do a practical job, but did not find it easy to state the facts on paper.

The system of part-time day courses was adopted for engineering apprentices at Woolwich; their employers gave them time off in order to attend the Woolwich Polytechnic on two half-days per week, and he believed they received their pay for those two half-days. It might be said that there would be difficulties in regard to the organisation at the works if young men were allowed to attend classes during the day-time; an employer might say that a chemist would commence an analysis during the morning and could not complete it in the afternoon if he had to attend classes. But the Americans had evolved a method, and he believed there was a good deal in it for our commendation and consideration. It was known as the co-operative system, whereby, for example, a firm having six apprentices would have only three of them in the works at one time, whilst the other three were spending a month or six weeks at the school; when the latter three returned to the works, the former three would go to the school.

The only hardship that he could see in that system was that the poor teacher at the school had to give the same lessons twice within a period of four, or six, or perhaps eight weeks. Whether or not some such scheme could be worked out for application to juniors in the foundries, he did not know. He had tried to envisage a scheme whereby a foundry having six apprentices might allow one of them to attend classes on each day in the week, so that there would always be five in the foundry; that might prove to be the nucleus of a practical suggestion.

MR. E. H. BROWN recalled that, about 18 years ago, on Tyneside, he had conducted classes for boys from the shops for two periods of one hour each every week. For part of the time the boys attended his classes, in which he had endeavoured to take a practical view of things, and for the other part of the time the effort was made to give them some notions in metallurgy; but on the metallurgical side the boys were instructed by a rather highbrow chemist, who could not bring his mind sufficiently far down into elementary considerations to be able to interest the boys.

Finally, Mr. Brown suggested that, in order to induce boys to continue to attend evening classes after the first year, the period of instruction in any class should be limited to one hour only, because, in his personal experience, the boys were capable of assimilating very much more information and knowledge during the first hour than during any subsequent period.

The vote of thanks to the authors and to Mr. Patchin was accorded on the proposal of MR. BOWMAN, seconded by MR. G. C. PIERCE, and at the close of the meeting the members were conducted around the laboratories to inspect the equipment used for the instruction of the students.

Book Reviews

The Alloys of Iron and Nickel: Volume I.—Special-Purpose Alloys. By J. S. Marsh. Published by McGraw Hill Publishing Company, Limited, Aldwych House, London, W.C.2. Price 36s.

This praiseworthy volume is the tenth in the Monograph Series dealing with Alloys of Iron Research, prepared under the supervision of the Iron Alloys Committee of the Engineering Foundation of U.S.A., the chairman and director of which is the Sheffield-born Prof. George B. Waterhouse. These Monographs are a concise but comprehensive summary of research on iron and its alloys, and contain a discussion of all available data on binary and higher ferrous alloy systems, and on the effect of alloying elements on carbon steel and on alloy steels and alloy cast iron.

The literature dealing with the alloys of iron and nickel is so vast that it has been impossible to compress the review into a single volume. The first volume, which is here reviewed, is devoted to the constitution and properties of binary and more complex iron-nickel alloys and to the properties of special-purpose alloys. In general it deals with iron-nickel alloys containing more than about 6 per cent. nickel, regardless of the carbon content. In the case of the iron-nickel alloys modified by the addition of chromium, the data are restricted to those materials containing more than 6 per cent. nickel and more nickel than chromium. The second volume of the Monograph will give a summary of data on the manufacture and properties of the nickel and nickel alloys commonly used for engineering and structural applications and containing generally less than about 6 per cent. nickel. It will also be a summary of information on all the nickel-containing cast irons.

Three chapters are devoted to a consideration of the iron-nickel system, the iron-carbon-nickel diagram and the constitution of complex iron-nickel alloys. In general, they treat the matter in a masterly way. In view of the enormous technical importance of iron-nickel-chromium alloys it is a pity, however, that the iron-nickel-chromium diagram is missing, and that only a dozen lines are devoted to it. The authors explain that it will be adequately discussed in Vol. 11, "Alloys of Iron and Chromium," which is to be published shortly.

The chapters on the physical properties of iron-nickel alloys and on thermal expansion are adequate, the latter being particularly comprehensive. Rather more than 100 pages are devoted to a consideration of the magnetic properties of magnetically soft iron-nickel alloys, but only fourteen pages are devoted to permanent-magnet materials containing iron and nickel.

The theoretical consideration of the demagnetising curve of permanent-magnet materials is considered in a somewhat old-fashioned way, and the authors still bring in the expression "de-magnetising factor." This is a theoretical treatment which does not readily lend itself to practical applications, and in these days one would have expected to find the subject developed on the magneto-motive force basis. The chapter devoted to mechano-magnetic properties, although short, is very comprehensive, and the material cited has been well chosen.

The creep stress and other high-temperature properties of a large number of alloys is given in the chapter devoted to mechanical properties, and here, fortunately, the properties of numerous Fe-Ni-Cr alloys are detailed.

This Monograph should appeal to all manufacturers and users of nickel alloys, and all readers will agree with the author in acknowledging the valuable work of Miss A. Rudorff of the New York office staff, who has prepared the bibliography and index.

J. FERDINAND KAYSER.

Some Episodes in the Manchester Association of Engineers. Published by the Association, St. John Street Chambers, Deansgate, Manchester, 3, for private circulation.

It is probable that the name originally selected in 1856 for the Manchester Association of Engineers—"The Association of Employers, Foremen and Draughtsmen of the Mechanical Trades of Great Britain"—represented some move on the part of the members to rid themselves of the appellation "mechanic," for prior to this period institutions of this character were described as "mechanics' institutes." This was probably due to the growth of industry, which demanded the employment of mechanics by mechanics. It was not until 1875 that the upper strata decided to label themselves "engineers." If they had only realised the transitory character of nomenclature they could have saved themselves much time and energy. In 1885 the present title was established.

Early meetings were held in local hostelries, and for the first two years there was a sixpenny levy for liquid refreshment. No long Papers were presented, and the meetings partook of an informal character. Apparently a magic lantern was used for the first time in 1887.

This book is anything but a dry-as-dust statistical review, but in as far as any history of an engineering association can be, it is a very human document, dealing with picnics, dinners, fines for not answering letters or attending committee meetings, the introduction of visitors, adventures in finance, and a strange ballot-box-cum-safe.

There is a link with this JOURNAL'S organisation, as in 1886 a discussion took place on Mr. J. Stephen Jeans' book on "England's Commercial Supremacy." The late Mr. Jeans was the father of the present chairman of directors of THE FOUNDRY TRADE JOURNAL.

The matter for this book has been compiled by Mr. A. C. Dean, a Vice-President of the Association, and he has produced a highly interesting book running to nearly 150 pages.

V. C. F.

Catalogues Received

Tool Tipping. The International Stellite Corporation, 30, East 42nd Street, New York City, has sent us a binder containing a number of pamphlets, each dealing with some phase of "stelliting." By "stelliting" is implied the process of applying a layer of "stellite" (a proprietary alloy) by means of a rod and the oxy-acetylene flame. These pamphlets are very practical, and each step to be taken is carefully set out and usually illustrated. One application which was new to the reviewer was the "stelliting" of plough shares. The whole subject of bestowing hard wearing surfaces by depositing and grinding is extremely interesting, and those to whom it appeals should write to New York for a set of these pamphlets.

Alloys. Though no good reason can be found for stating that to the metallurgist a list of available metals and alloys is amongst the most fascinating of trade literature, yet we are reasonably certain that the twelve-page book just issued by Blackwell's Metallurgical Works, Limited, of Speke Road Works, Garston, Liverpool, 19, will be hoarded by every recipient. It is probably due to some sub-conscious idea that, if only time were available, some epoch-making alloy would be discovered by compounding some of the many dozens of alloys listed. Now that alloying in the iron foundry is common practice, this booklet should be appreciated in what is still a new sphere of activity in this industry. The injunction "Keep this list for reference," printed on the second page, is, it is felt, quite unnecessary, as it will be a prized possession by recipients.

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The Week's News in Brief

Trade Talk

AN ORDER for 400 wagons has been received by Hurst, Nelson & Company, Limited, Motherwell, from a firm in North-East England.

WILLIAM GRAY & COMPANY, LIMITED, of West Hartlepool, have booked an order to build a 9,000-ton cargo boat for W. H. Cockerline & Company, of Hull.

THE ANNUAL staff dinner of the Park Foundry (Belper), Limited, which was held at the Railway Hotel, Belper, attracted a large attendance of employees and friends.

A SCHEME for the erection and equipment of a block of factories has been begun at Lea Hall, on the Coventry side of Birmingham, which is estimated to cost £1,000,000.

THE AIR MINISTER, Sir Kingsley Wood, is to visit Grantham next week to open the new factory of British M.A.R.C., Limited, which is almost ready to commence production.

THE AMALGAMATED ENGINEERING UNION records that during 1938 the membership rose by 36,555, and on December 31 was 368,508. Unemployment increased from 6,319 to 10,035.

ALREADY 69 MEMBERS of the Institution of Mechanical Engineers, accompanied by 48 ladies, have intimated their intention to take part in the Institution's American summer meeting.

THE SIMPLEX ELECTRIC COMPANY have recently supplied a Creda cooker to a blind housewife, the switches and instruction card being printed in Braille. It has been an unqualified success.

A REPEAT ORDER from J. & E. Hall, Limited, of Dartford, for the Blue Star Line for four 250 b.h.p. Brush Diesel engines, making 20 in all, has been received by the Brush Electrical Engineering Company, Limited.

AS A RESULT of a visit to Turkey by the secretary of the Locomotive Manufacturers' Association, Mr. J. W. Vaughan, it is anticipated that a contract will shortly be placed in this country for the supply of 42 locomotives for the Turkish State Railways.

PLANS for a steel-framed warehouse at the Denny Iron Works, of Cruikshank & Company, Limited, Denny, have been approved by the local Dean of Guild Court. Underneath the new building an air-raid shelter is to be constructed, with accommodation for 300 workers.

WITH THE DEVELOPMENT of new industries and the resuscitation of many of the heavy engineering and ancillary trades in the North of England, especially on the North-East Coast, David Brown & Sons (Hudd), Limited, Huddersfield, gearing specialists, have opened a branch office at Lloyds Bank Chambers, Albert Road, Middlesbrough. Mr. A. Richardson will be the district manager.

THE PARTNERSHIP between Messrs. Joseph Bowles, George Richard Bowles, Horatio Davies Evans and John Thomas Cornelius, carrying on business as brass and ironfounders at the Titan Foundry, Dumballs Road, and Christie's Foundry, Loudoun Square, Cardiff, under the style of Evans' Titan Foundry Company, has been dissolved. Debts will be received and paid by the Titan Foundry Company, Limited, of Dumballs Road, Cardiff, who will continue the business.

THE EXECUTIVE of the Amalgamated Engineering Union has decided to request a further conference with the Engineering Employers' Federation. They wish to discuss the refusal of the employers to concede the claims of the union for a substantial increase in wages, the restoration of the pre-June, 1931, working conditions, and the consolidation of bonus into wage rates. When this conference is arranged, it is hoped that a compromise offer may be forthcoming. The Confederation of Engineering and Shipbuilding Unions, which has also received a refusal to its claims, has already decided to ask for a further conference with the employers, with a view to elucidating certain points in the employers' reply. The claim of the Confederation, which covers all the unions in the engineering trades except the A.E.U. and the National Union of Foundry Workers, is for an increase in wages for time-workers and an equivalent advance to those under the system of payment by results; a shorter working week; and the restoration of the rates and conditions which operated prior to June, 1931, as affecting piece-work, overtime, night-shift and shift conditions.

Personal

MR. R. C. TUCKER, of Newton, Chambers & Company, Limited, has been elected President of the Sheffield Metallurgical Association for 1939.

MR. G. H. NISBETT has been elected deputy-chairman of British Insulated Cables, Limited, in addition to retaining his position as managing-director.

MR. CHARLES BUCKLE, senior lecturer in engineering at Southall Technical College, has been appointed head of the Engineering Department of Hendon Technical Institute.

MR. TOM PEACOCK, well-known throughout the Midlands as managing director of Guest, Keen & Nettlefolds, Limited, Darlaston, was 70 years of age on Friday, January 6.

MR. B. L. PAGE has changed his position from foundry manager at Specialloid, Limited, to manager of the aluminium department of John Dale Metal Containers, Limited, of New Southgate, London, N.11.

MR. W. H. BAILEY, who has retired from the position of hon. secretary of the Sheffield Metallurgical Association after ten years' service, received a presentation at the annual meeting of the Association last week.

MR. W. H. MEADOWCROFT, a Past-President of the Lancashire Branch of the Institute of British Foundrymen, is now the landlord at the Freemasons' Arms, Todmorden, in Lancashire. We wish him every success in his new sphere.

MR. R. D. LAWRIE, who has been manager of the light and heavy foundries and dressing shop of Glenfield & Kennedy, Limited, Kilmarnock, for 8½ years, has taken up the post of works manager with Brightside Foundry & Engineering Company, Limited, Sheffield. Before he left Kilmarnock, Mr. Lawrie entertained the works foremen, foundry staff and representative members of the light foundry pieceworkers to dinner in the recreation hall at the works. He was presented with a gold watch, suitably inscribed, from the works' staff, which was handed to him by Mr. Henry Gardiner, works manager. From the light foundry workers Mr. Lawrie was presented with a travelling case.

Wills

WARD, W. A., of Sheffield, assistant managing director of Thos. W. Ward, Limited	£11,140

Obituary

MR. WALTER HILL FREEMAN, chairman and managing director of Richard Duckering, Limited, ironfounders, Lincoln, died recently.

MR. WALTER SMITH died at Keighley last week, aged 69. Until about ten years ago he was a director of John Smith (Keighley), Limited, crane makers, Keighley.

THE DEATH took place last week of Mr. T. H. Neville, who for many years was senior partner in the firm of T. C. Neville & Sons, ironfounders and engineers, of Walsall.

Company Reports

J. & E. Hall, Limited.—Ordinary dividend of 10 per cent. for the year ended September 30.

Westinghouse Brake & Signal Company, Limited.—Net profit for the year ended September 30, after tax, £262,518; brought in, £70,569; dividend of 10 per cent. and a cash bonus of 7½ per cent.; to general reserve, £75,000; to staff pensions account, £10,000; carried forward, £105,106. Meeting, February 14.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"CELLOTIN" and "CELLOX."—Pistons and piston rings. Light Production Company, Limited, 60/66, Rochester Row, London, S.W.1.

"INCONEL."—All goods included in Classes 6, 7, 9, 10 and 11. Henry Wiggin & Company, Limited, Thames House, Millbank, London, S.W.1.

Contracts Open

Gainsborough, January 27.—Cast-iron pipes during the year ending March 31, for the Urban District Council. Mr. Stanley Algar, surveyor, Council Offices, Gainsborough.

Hertford, February 14.—Construction of 1¾ miles of 75-in. dia. sewer in steel and concrete pipes and cast-iron segments, and 1 mile of 15-in. dia. sewer in iron and concrete pipes, etc., for the Colne Valley Sewerage Board. Sandford Fawcett & Partners, consulting engineers, 53, Victoria Street, Westminster, London, S.W. (Fee £10 10s., returnable.)

Hull, January 25.—Iron castings, iron and steel, etc., for 12 months from April 1, for the Kingston-upon-Hull Corporation. The City Engineer, Guildhall, Hull.

London, S.W., January 27.—Iron castings and bars, etc., for the 12 months from April 1, for the Battersea Borough Council. Mr. R. G. Berry, town clerk, Town Hall, Battersea, London, S.W.11.

London, S.E., February 1.—Sewer ironwork, etc., for the Southwark Borough Council. Mr. D. T. Griffiths, town clerk, Southwark Town Hall, Walworth Road, London, S.E.17.

London, W., January 25.—Cast-iron draw-boxes, frames and covers; cables (paper and rubber insulated); metals (non-ferrous), etc., for 12 months from April 1, for the Hammersmith Borough Council. The Chief Electrical Engineer, "Electric House," 154, Uxbridge Road, London, W.12.

Macclesfield, February 8.—Iron castings for 12 months, commencing April 1, for the Borough Council. Mr. E. Hamson, borough surveyor, Town Hall, Macclesfield.

Slaithwaite, February 4.—Cast-iron work for 12 months commencing April 1, for the Colne Valley Urban District Council. The Surveyor, Council Offices, Marsden, near Huddersfield.

Smethwick, January 28.—Castings for 12 months ending March 31, 1940, for the Corporation (Public Works Department). Mr. Roland Fletcher, borough engineer, Council House, Smethwick.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Star Metal Spraying & Welding Company, Limited, 61, Regent House, 235, Regent Street, London, W.1.—Capital, £100.

Digby Stainless Steels, Limited, 6, Queen Anne's Gate, London, S.W.1.—Capital, £30,000. Directors: E. T. and W. P. Digby.

Contimetal Industry, Limited.—Capital, £1,000. Metal alloy manufacturers, etc. Directors: E. Meuller, Dr. G. Tausz and D. D. C. Giddins, Skerrens Park, Willingale, Essex.

Forthcoming Events

JANUARY 26.

Institution of Mechanical Engineers (East Midlands Branch):—Joint meeting with Lincoln Engineering Society. "Precision Measurement as Applied to Engineering Practice," Paper by K. E. Summers, at Technical College, Lincoln, at 7.15 p.m.

Institution of Structural Engineers:—Joint meeting with Institution of Chemical Engineers. "Floors for Industrial Purposes," Paper by R. Fitzmaurice and Dr. F. M. Lea, at 11, Upper Belgrave Street, London, S.W.1, at 6.30 p.m.

Keighley Association of Engineers:—"Production, Strength and Application of the New Alloy Cast Irons." Paper by H. A. MacColl, at Victoria Hotel, Keighley, at 7.30 p.m.

JANUARY 27.

Manchester Association of Engineers:—"Technical Aspects of Railway Electrification." Paper by J. E. Calverley, at Engineers' Club, Manchester, at 7.15 p.m.

Institute of British Foundrymen

JANUARY 23.

Lincolnshire Section:—"Thirty Years of Progress in Cast Iron." Paper by Dr. A. B. Everest, at Lincoln Technical College, at 6.45 p.m.

JANUARY 28.

Birmingham Branch:—Annual dinner and dance, at Botanical Gardens, Edgbaston, Birmingham.

Burnley Section:—Annual social, at Greenwood's Café, Todmorden Road, Burnley.

East Midlands Branch:—"Notes on the Manufacture of Steel Castings," Paper by C. D. Pollard, at Technical College, Derby, at 6 p.m.

Newcastle-upon-Tyne Branch:—"Sand Testing," Paper by N. D. Ridsdale, at Neville Hall, Newcastle-upon-Tyne, at 6.15 p.m.

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Raw Material Markets

Although contract specifications have recently been on a much better scale than was the case at the end of last year, new business in foundry pig-iron remains rather quiet. Producers are mostly in possession of heavy stocks, and it is probably the fact that consumers are assured of prompt delivery at any time that is causing them to hesitate before entering into forward contracts.

Pig-Iron

MIDDLESBROUGH.—The production of Cleveland foundry pig-iron has not been expanded very much since the commencement of the year, and stocks at some makers' works will not last them very long unless business fails to materialise as anticipated. At present, there has not been any rush to enter into forward contracts, but most consumers are taking contract deliveries on a freer scale. It is expected that there will shortly be a resumption of large-scale buying, as some contracts are due to expire in the near future. Producers are keeping a careful watch on the position and will readily bring more furnaces into operation when occasion demands. Owing to the considerable difference between home quotations and those ruling on the Continent, little business with oversea consumers is possible.

There is a firmer tone in the hematite section of the market. New business remains somewhat quiet, but users are calling for increased tonnages against contracts, indicating that their order-books are in a healthier condition. Most of the orders now circulating are for short periods. It is hoped in this district that some benefit will accrue as a result of the Anglo-Italian talks in Rome last week. Exporters here have felt the loss of the Italian trade very severely and would welcome a resumption of business if a satisfactory scheme could be evolved whereby payments would be guaranteed.

LANCASHIRE.—Producers do not attempt to hide their disappointment at the scarcity of business in this area since the beginning of the year. It had been confidently hoped that the lower prices now in operation would have resulted in a good number of long-term orders being placed, but such has not been the case. In some instances, however, makers report that they are fairly well satisfied and that users have displayed willingness to negotiate ahead, but, on the whole, trade is confined to small tonnages for prompt delivery. A small expansion of business has been noticeable in the hematite section, and some consumers have renewed their contracts over a few months ahead.

MIDLANDS.—High-phosphorus iron is not in very brisk demand, and business is still of a hand-to-mouth character. Conditions in the light-castings trade are unsatisfactory, and not much improvement is anticipated before the spring. Much depends upon a revival in the building industry. For delivery to local stations, Derbyshire No. 3 iron is quoted at 101s., with Northamptonshire No. 3 at 98s. 6d. per ton, less 5s. rebate. More activity is evident in the demand for low-phosphorus iron, and quite a good number of orders has recently been forthcoming. Current prices now range from £5 5s. to £6 per ton, delivered to Birmingham and district. There has certainly been a better call for contract deliveries of hematite, but the reluctance to enter into new contracts remains. In most cases, it will be some considerable time before existing commitments expire and the current production is likely to be adequate.

SCOTLAND.—Only small tonnages are changing hands in this area, and the amount of business passing is not very encouraging, although makers are still hopeful that consumers will shortly fix up new contracts. Short-time working is general at most of the light-castings foundries, and consumption of pig-iron is naturally at a low ebb. No. 1 Scottish foundry iron is quoted at 108s., with No. 3 at 105s. 6d., f.o.t. furnaces. The local steelworks have restarted after the holidays with a better outlook, but they are mostly covered for their requirements of iron. Quotations for steel-making irons are:—Hematite mixed numbers, 120s. 6d.; English and Indian basic, 92s. 6d., less 5s. rebate, delivered steelworks.

Coke

There has been a better call for contract deliveries of foundry coke from the ironworks, and the pits are consequently quite well employed, but new business generally is of a quiet nature. Prices have been fixed at a minimum of 50s. 6d. per ton up to the end of the first half of the year, and so there is little incentive for consumers to rush to make new contracts.

Steel

The home demand for steel sheets has not yet expanded so much as had been hoped for, but already there have been orders in connection with A.R.P. work, and it is expected that this section of the defence programme will shortly incur the consumption of a heavy tonnage of sheets. Steel bars and strip continue to be in better request, but rollers could do with still more business. Business in structural steel remains on the quiet side, but stainless steel is being taken up in still heavier tonnages, and the outlook for this section is very satisfactory.

Scrap

Although business in the iron and steel scrap market has expanded slightly during the past week, especially in South Wales, trade generally is still unsatisfactory. The tonnages called for are very much below the average. In most cases, orders are for small parcels for early delivery, and there is a dearth of contract business. Steelworks are only taking up restricted supplies, and until there is an improvement among these consumers, the outlook will remain unsatisfactory.

Metals

Copper.—Publication of the American Copper Institute's statistics for the month of December reacted unfavourably on the market. The figures, which recorded an expansion of over 32,000 short tons in the stocks of refined metal, made an unexpectedly poor showing. Domestic stocks of blister copper increased by 4,586 tons. Consequently, the tone of the market was somewhat undermined. Industrial buying in Europe has been on a low scale, but Japan has continued to take up substantial tonnages. As a result of the Prime Minister's talks with Signor Mussolini it was hoped that some clarification of the international outlook would be forthcoming, but the statement issued jointly by the two parties after the conclusion of the negotiations did not suggest any definite improvement, and commercial conditions did not benefit to any extent. In the United States, business continues to be rather weak, and new sales are not very substantial, although it is anticipated that there will be some expansion in the near future.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £42 13s. 9d. to £42 16s. 3d.; Friday, £42 18s. 9d. to £43; Monday, £43 1s. 3d. to £43 2s. 6d.; Tuesday, £42 10s. to £42 11s. 3d.; Wednesday, £43 1s. 3d. to £43 2s. 6d.

Three Months.—Thursday, £43 1s. 3d. to £43 2s. 6d.; Friday, £43 3s. 9d. to £43 5s.; Monday, £43 7s. 6d. to £43 8s. 9d.; Tuesday, £42 15s. to £42 16s. 3d.; Wednesday, £43 6s. 3d. to £43 7s. 6d.

Tin.—There has been little change in the condition of this market during the past week, and business continues to be quiet, consumers making no efforts to cover themselves ahead. The future of tin is closely linked up with the international situation, which does not appear to be very favourable at the present moment, although a continuance of negotiations between the various countries as a means of threshing out the numerous and complicated problems now confronting European States should ensure that difficulties are met in a sane manner. Also, the slow expansion of the United States industrial conditions is retarding a return to better trading in this country. The American tinplate trade is now operating at around 40 per cent. of normal capacity; while this is an improvement on recent returns, the rate of operation is still unsatisfactory.

Official quotations were as follow :—

Cash.—Thursday, £216 5s. to £216 10s.; Friday, £216 5s. to £216 15s.; Monday, £216 to £216 10s.; Tuesday, £215 10s. to £215 15s.; Wednesday, £216 7s. 6d. to £216 10s.

Three Months.—Thursday, £217 to £217 2s. 6d.; Friday, £217 2s. 6d. to £217 5s.; Monday, £216 15s. to £217; Tuesday, £216 7s. 6d. to £216 10s.; Wednesday, £217 2s. 6d. to £217 5s.

Spelter.—The chief feature of this market during the past week has been the better demand from the galvanising section. It is believed that galvanising works will benefit to a large extent as a result of the Government's A.R.P. plans, although definite news of the part that the galvanising trade is to play in this section of the defence programme is still awaited. It is, however, thought likely that between 5,000 and 6,000 tons of spelter valued at from £70,000 to £80,000 will be required for galvanising the 100,000 tons of steel sheets which the Government has ordered under the first part of its £20,000,000 A.R.P. scheme. The galvanisers have been quiet for a long time past.

Daily market prices :—

Ordinary.—Thursday, £13 10s.; Friday, £13 18s. 9d.; Monday, £13 16s. 3d.; Tuesday, £13 15s.; Wednesday, £13 13s. 9d.

Lead.—The Soviet Union has shown some interest in this metal, but, on the whole, European business has been quiet. The United States market has been less active of late following a period of quite heavy buying. The American Bureau of Metal Statistics reports that the world's output during November last totalled 150,600 short tons, as compared with 155,700 tons in October.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 10s.; Friday, £14 12s. 6d.; Monday, £14 8s. 9d.; Tuesday, £14 6s. 3d.; Wednesday, £14 10s.

Scrap.—With the exception of duralumin, which remains in good demand, business in non-ferrous scrap metal is on a quiet scale. There has been a slight improvement in the demand from Germany, but trade with this country is nothing like what it was a month or two ago. With the exception of copper and zinc prices, which are unchanged, quotations are lower on the week.

Approximate selling prices for old metal:—New aluminium cuttings, £70; rolled, £54 to £55; cast, £32; foil, £80. Copper, £36 to £42; braziery, £33 to £35. Brass (clean), £20 to £24. Zinc, £10. Lead, £14. Gunmetal, £36.

Steel Castings for Motor Vehicles

(*Continued from page* 78.)

Fig. 2 shows the steel mould and cores now being used on this machine to produce the double casting for the two gears shown at the right. The position and purpose of the six cores shown will be easily understood by their relative positions in the picture. Dead-load tests of the finished gear made from the casting show it to be fully as good as the gears made from forgings. This is also true of impact tests on gear teeth. Life tests under overload of the finished transmissions show the cast gear to have a considerable advantage.

In the case of the cast gear the best macro structure is found where most strength is needed. The poor structure in the centre is removed by drilling the hole for the shaft. In the case of the forged gear, a weakness will be found parallel and near the base of the gear teeth where the greatest strength is needed.

Microphotographs show that both types are very similar, even as to grain size, this being in the ratio of 5 to 7.

In Fig. 3 are shown (1), at the upper right, this same transmission gear with feeders in position; (2), at lower right, the lorry rear-axle ring gear; (3) the passenger-car ring gear, and (4) other gears which have been produced on an experimental scale.

These developments certainly point to a definite trend towards the replacement of forgings by castings. However, this competition is spurring forging sources to greater efforts and there was one case in the last year where a forging replaced a casting, to advantage. This competition thus furthers greater progress and benefits both the user of the finished part and the ultimate consumer, this being in this case the motor-vehicle purchaser.